
MAP OF SCOTLAND
Engraved
for the Outline of the
Mineralogy
OF THE SCOTTISH ISLES
NORTHERN OCEAN
ORKNEY ISLANDS
PENTLAND FIRTH
SUTHERLAND SH.
CAITHNESS SH.
DORNOCH FIRTH
MURRAY FIRTH
ROSS SH.
INVERNESS SH.
ELGIN SH.
BANFF SH.
ABERDEEN SH.
KINCARDINE SH.
ANGUS SH.
PERTH SH.
FIRTH of TAY
FIFE SH.
FIRTH of FORTH
ARGYLE SH.
STIRLING SH.
DUNBARTON SH.
LINLITHGOW SH.
HADDINGTON SH.
EDINBURGH SH.
RENFREW SH.
LANERK SH.
PEEBLES SH.
BERWICK SH.
SELKIRK SH.
ROXBURGH SH.
AYR SH.
DUMFRIES SH.
KIRKUDBRIGHT SH.
WIGTON SH.
BRITISH SEA
WESTERN OCEAN
IRISH SEA
IRELAND
ENGLAND
LEWIS
HARRIS
N. UIST
S. UIST
SKYE
MULL
ISLA
JURA
ARRAN
SOLWAY FIRTH
LUCE BAY
WIGTON BAY
Geographical Miles 60 to a Degree

MINERALOGICAL TRAVELS

THROUGH THE

HEBRIDES, ORKNEY AND SHETLAND ISLANDS,

AND

MAINLAND OF SCOTLAND,

WITH

DISSERTATIONS UPON PEAT AND KELP.

IN TWO VOLUMES,

ILLUSTRATED WITH MAPS AND PLATES.

BY ROBERT JAMESON,

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VOLUME I.

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PREFACE.

I UNDERTOOK the journeys, of which I now preſume to lay the notes before the public, in order to acquire, from actual obſervation, a knowledge of the mineralogy of the Scottiſh Iſles.

I have choſen the form of a journal, becauſe I wiſhed to convey the information I had gleaned in the ſtile of detailed obſervation, and in that order which the appearance of the country naturally ſuggeſted. But, in adopting this form, I am anxious to caution the reader againſt expecting that entertainment, and kind of information, which form the groundwork of the many journals through the more intereſting parts of our iſland. If any one ſhall find this Outline of the mineralogy of theſe countries deficient in incident, in epiſodes and ſtories, and in deſcriptions of pictureſque and romantic

fcenery; let him recollect, that to indulge in fuch defcriptions was incompatible with the defign of this work. I do not defpife thofe ornaments; and I hope that I have not been infenfible to the emotions which naturally arife from the retired and ftriking fcenes which often burft upon me in the unfrequented tracts which my purfuits led me to explore: but I have thought it foreign to my purpofe to obtrude thefe things upon the public.

Another refolution I had formed to myfelf, and which partly indeed led me to choofe the form of a journal, was, to fhun the fafcinating evil of fpeculation and hypothefis, which mars all faithful obfervation. It would ill fuit my talents to venture upon deep fpeculation, were I inclined; and perhaps the ftate of mineralogical knowledge forbids it. It is a fitter tafk for me to record faithfully what I have myfelf examined, and to give a fair report of the materials which were collected, than to expofe myfelf, by the form or arrangement of the work, to the danger of having the facts twifted and perverted by hypothefis, the rage for which is as remarkable in this as in the other fciences.

While, in mineralogical purfuits, there is much to intereft a philofophical mind, the object of true value is its application

to

to economical purpofes. I fear that the theories of the formation of the earth, interefting as they are, often miflead the mind, and pervert the underftanding; and thofe who yield to them, become fo involved in delufive fpeculations, fo blind to fact and experience, that, like Archimedes, they find but one thing wanting to raife worlds.

Of the utility of this fcience there can be no queftion; more particularly when it is freed from the vague fuppofitions of the theorift. It is a ground-work, without which the obfervations of the geologift, and the labours of the miner, will ever be uncertain, and of little utility. It is a fcience, the cultivation of which will raife a country to importance, by exciting new fources of induftry, even in fituations where the labours of the hufbandman will be employed in vain. But, though I am well convinced that the importance of every thing in mineralogy is in proportion to its accuracy, I would not be underftood to reprefent thefe notes as a complete account of the mineralogy of the countries of which they treat—I give them to the public as an imperfect outline. The mineralogical hiftory of a country is to be accomplifhed only by ftudying at leifure all the varieties and difpofition of the ftrata and veins, and the appearances of the mountains and valleys: an inveftigation which the utmoft care, in a rapid furvey, muft leave in

many particulars imperfect, eſpecially when the mineralogiſt is perplexed with the difficulties of travelling among unfrequented iſlands.

I have in this, as in a former work, ſeparated the particular account of the ſtrata and veins from that of the particular foſſils; as the common method of conjoining them appears often to lead to confuſion, and can never be ſufficiently correct. In deſcribing the foſſils, the method and nomenclature of the beſt mineralogiſts has been followed. The chemical characters, which form even the foundation of many mineralogical ſyſtems, I have ſeldom employed; from a conviction that the chemical part of mineralogy, notwithſtanding the late improvements in the art of analyſis, is ſtill to be conſidered as imperfect. We have only to obſerve the contradictory reſults obtained by the beſt chemiſts in decompoſing the ſame foſſil, to be convinced that the analyſis of the preſent day, although much improved ſince the time of Bergman, is ſtill of no very great utility in mineralogy.

The drawings of ſcenery, and the mineralogical plans, which accompany this work, were executed by the elegant pencil of my friend Mr. Charles Bell. In the views of ſcenery, he has happily expreſſed the different characters which the rocks aſſume from the effects of the weather; a circumſtance which renders

renders them the more valuable. The mineralogical plans are of much confequence in elucidating feveral curious facts, which otherwife would with difficulty have been underftood. Thefe engravings are not to be judged of as picturefque reprefentations—they were not intended as ornaments, nor were they felected as being the moft beautiful: the defign being to mark the characteriftic features of the fcene, not as a landfcape, but as a mineralogical delineation.

CONTENTS.

VOLUME I.

CHAP.

INTRO-

INTRODUCTION,

CONTAINING

An Abſtract of the Wernerian Account of the different Kinds of Mountain Rocks; with Geognoſtic Obſervations on the Strata of the Scottiſh Iſles, and ſuch parts of the Mainland as are mentioned in this Work.

AS I ſhall frequently have occaſion to mention in this work the diviſion of rocks into Primary, Tranſition, and Stratified, it may be uſeful to many to know the characters by which theſe different rocks are diſtinguiſhed. I am the more anxious to do this, as we have not, as yet, in any Engliſh publication, an account of the diviſion. To this I ſhall add a few geognoſtic obſervations upon the different rocks to be found in the Scottiſh

iſles, and in thoſe parts of the Mainland which are mentioned in the following Outline.

According to the lateſt obſervations, all the ſtrata, of which our globe is compoſed, may be arranged under the following claſſes: The Primary, (Urgeburge); the Tranſition, (Ubergangsgeburge); the Stratified, which comprehends what are called the ſecondary ſtrata, (Flotzgeburge); and the Volcanic, Alluvial, (Aufgeſchwemmte.)

I ſhall now mention the diſtinction between theſe different kinds of ſtrata; and, firſt, of the

PRIMITIVE.

Theſe ſtrata are characteriſed by their never containing the remains of animals or vegetables, nor alternating with ſuch ſtrata as contain theſe relics. Humbold has alſo obſerved that the primitive ſtrata in Europe are always inclined towards the N. E., while the ſtrata of the ſecondary mountains dip towards the S. E.

It is to the celebrated mineralogiſt John Gottlob Lehman that

that we are indebted for the very important difcovery of the divifion of mountains into primary and fecondary. Since he wrote, fucceeding mineralogifts have confirmed the truth of his obfervations, and have thus raifed geology, from a vague and confufed ftate, to a high pitch of certainty and utility. A few writers have tried to overturn this diftinction, *by afferting that it is* fanciful; yet thefe fpeculations, like all others not founded on truth and accurate inveftigation, have funk into deferved oblivion.

The primitive ftrata are the following: granite, gneifs, micaceous fhiftus, ardefia, fienite, porphyry, primitive limeftone, primitive greenftone, greenftone fhiftus, ferpentine, quartz, pitchftone, and topaz rock. Granite is confidered by Werner as the fundamental rock, or that upon which all others are laid, and it is but very rarely that it alternates with other rocks. It is difpofed in layers or ftrata, which are often enormoufly thick, and frequently horizontal, and extend thus for many miles through a whole chain of mountains. All the other primary ftrata alternate with each other, but never with the tranfition or ftratified rocks. The greenftone, wacken, and pitchftone are the only exceptions; the two firft being common to the three firft-mentioned formations, but the pitchftone only to the primary, and ftratified, or flotzgeburge. The

TRANSITION, OR UBERGANGSGEBURGE

comprehend all thofe rocks, the lowermoft ftrata of which contain few or no petrifactions; in the higher they are more abundant; but only petrifactions, the originals of which no longer exift. Thefe mountains alfo abound in metallic veins and in grottos. Thofe of Antiparos, Crete, &c. are in this kind of rock; as are the Hartz metalliferous mountains, and thofe of Derbyfhire. They feem to have been formed after the primitive, and earlier than the ftratified (flotzgeburge) rock. The ftrata of this formation are the following: grawacken, grawacken flate, fandftone, fome fpecies of ardefia, greenftone, mandelftone, limeftone, and Dr Reufs conjectures that fome fpecies of fienite and porphyry * may belong to this clafs of rocks. The

STRATIFIED (*Flotzegeburge*)

appear to have been formed after the tranfition rocks. They confift of fandftone, limeftone, argillite, with numerous petrifactions;

* Mineralogifche Geographie von Bohmen, 2 Band, § 177.

factions; alfo, bafalt, fhiftofe porphyry, pitchftone, greenftone, wacken, and the various coal ftrata.

From the view of thefe three formations, we obferve that the greenftone and wacken occur in every one of them, but the bafalt is peculiar to the ftratified rocks. The

VOLCANIC

comprehends the various ftony fubftances altered by action of fire: thefe are, lava, pumice, vocanic afhes, and volcanic tuff. The

ALLUVIAL

confift of gravel, fand, clay, &c. and are the debris of the other ftrata.

Having thus mentioned the divifion of the different rocks, according to their relative antiquity, I fhall now make a few general geognoftic obfervations on the rocks of the Scottifh ifles, &c. I fhall firft mention the

PRI-

PRIMARY ROCKS.

Granite. This rock forms but a ſmall portion of the Scottiſh iſles, it being found only in the iſle of Arran, and in the low part of Mull called Roſs, and in the Shetland iſlands. Upon the Mainland, however, I obſerved it forming mountains in Sutherlandſhire, a conſiderable part of the county of Aberdeenſhire ſeems to be formed of it, and alſo the lofty mountain of Cruachan upon the weſt coaſt. Granite veins are pretty frequent in ſeveral of the iſlands, as in Arran where they traverſe the common granite, and in Coll, Tiree, Rona, the Orkney and Shetland iſlands, &c. where they traverſe micaceous ſhiſtus, gneiſs, or hornblende ſlate. Upon the mainland, in the route from Bernera to Perth, the granite veins are extremely common.

Gneiss. This rock I obſerved in Coll, Tiree, Raſay, Rona, in the Shetland iſlands, and in ſeveral places upon the Mainland of Scotland; in particular it forms the ſummit of the high mountain called Ben Lomond. It ſometimes alternates with micaceous ſhiſtus and hornblende rock, and it is traverſed by granite veins, as is the caſe in Coll, Rona, &c.

Micaceous Shistus. This rock forms a portion of the iſles of

of Arran, Bute, and Mull; it is juſt to be obſerved in Coll, but a very conſiderable extent of the Shetland iſlands are compoſed of it. In the Mainland it appears to extend through the whole diſtrict of Cowal, and to the extremity of the iſthmus of Cantyre, and in all the country from Bernera to Dunkeld; and from Dunkeld to Loch Lomond by Inveraray, the micaceous ſhiſtus is the prevalent rock. Upon the eaſt coaſt it is frequent among the other primary ſtrata. It alternates with ſhiſtoſe quartz in the iſland of Mull, and with hornblende and gneiſs in the iſland of Coll; and it is to be obſerved in ſeveral places paſſing to ardeſia, and it is traverſed by granite veins, and has pieces of granite encloſed in it.

Ardesia. Primitive argillaceous ſhiſtus. This rock occurs in Arran, Bute, Iſla, Jura, Eaſdale, and Seil. In Iſla there is a ſpecies of it which contains pieces of granite, which, however, ſeem to have been formed at the ſame time with the ardeſia. In Eaſdale, Seil, Bute, and Arran, it it quarried for economical purpoſes; but the ſlate of Eaſdale is by far the beſt.

Sienite. A rock nearly allied to ſienite ſeems to form the craig of Ailſa; it alſo forms part of the iſland of Arran, and the lofty Cullin moutains in the iſland of Skye.

Por-

Porphyry. I obſerved fragments of porphyry among the granite mountains in the iſland of Arran, which is probably of primitive formation, and the porphyry, which forms ſo conſiderable a part of the hill of Glamoſcard in Skye, ſeems to be of primitive formation.

Primitive Limestone, or Marble. This rocks occurs in vertical ſtrata at I-columb-kill, alſo in the iſland of Tirie, and in ſeveral parts of the Mainland. I obſerved it alternating with primary rocks, particularly at Portſoy, where it is in vertical ſtrata and alternates with talcaceous ſhiſtus and ſerpentine.

Primitive Greenstone. I have not met with this rock in any part of Scotland excepting in the iſland of Iſlay, yet I think it very probable that a careful examination may diſcover it in many places.

Serpentine. There are no ſtrata of this rock in the Hebrides, nor the Orkney iſlands; but in Shetland it forms extenſive hills, and there it ſeems evidently to be of primitive formation. At the intereſting ſpot, Portſoy, there are great vertical ſtrata of ſerpentine alternating with marble, talcaceous, and hornblende ſhiſtus.

Quartz.

Quartz. In the iſlands of Iſla and Jura there are mountains of granular quartz, and it is there to be obſerved alternating with, and paſſing into micaceous ſhiſtus. In the iſle of Coll there are alſo conſiderable rocks of granular quartz. In the iſland of Tirie I obſerved the rare appearance of a vein of granular quartz traverſing ſtrata of micaceous ſhiſtus and hornblende ſlate. In Caithneſs the mountain of Scaraban is compoſed of quartz; and at Portſoy there is a hill which affords ſhiſtoſe quartz. In many places veins of quartz are to be obſerved traverſing the primary ſtrata, and in the iſland of Bute there is a quartz vein which preſents appearances irreconcileable with the Plutonic theory.

Pitchstone. The only ſpecies of this ſtone which I have ever ſeen, that may be conſidered as primary, is that upon the hill of Glamoſcard in the iſland of Skye. It there ſeems to alternate with porphyry, but of this I am not as yet certain. In the iſland of Arran there are appearances of pitchſtone in the form of veins traverſing the granite, but as all veins are of an after formation to the rocks which they traverſe, this cannot be reckoned equally old with the granite, or other primitive rocks.

TRANSITION ROCKS, *(Ubergangſgeburge.)*

Grawacken. This is a rare rock in the diſtricts through which I paſſed. The only appearance I ever noticed was a ſmall portion lying on ardeſia in the iſland of Seil.

Greenstone. The greenſtone of the iſland of Mull appears to belong to this formation, as it is found near to limeſtone that contains belemnites.

Limestone. This ſpecies is found in the iſland of Mull, and contains in it cornu ammonis and belemnites; hence I reckon it to belong to the tranſition rocks.

STRATIFIED ROCKS, *(Flotzgeburge.)*

Sandstone. Of this I obſerved two kinds, the ſiliceous and argillaceous.

The ſiliceous does not frequently occur. The ſandſtone of the iſland of Rume approaches nearly to this kind, and in the Orkney iſlands there are ſtrata of ſiliceous ſandſtone that al-

ternate

ternate with argillaceous ſandſtone. Argillaceous ſandſtone forms the Cumbray iſlands, the ſouth extremities of Bute and Arran; and it alſo appears in the iſlands of Seil, Mull, Eigg, Skye, Raſay and Scalpa. Almoſt the whole of the Orkney iſlands are compoſed of argillaceous ſandſtone, but it forms a very ſmall portion of the Shetland iſlands. It alſo ſkirts the eaſt coaſt of Scotland from the Pentland Firth to the ſmall fiſhing town called Buckie; and again this ſandſtone makes its appearance near to Aberdeen, and continues along the ſhore all the way to the Frith of Forth.

Limestone. In the iſland of Arran there are conſiderable ſtrata of limeſtone which is covered by argillaceous ſandſtone; and in ſome places the limeſtone and ſandſtone alternate. In the Orkneys limeſtone is to be obſerved covered by ſandſtone, and even traverſed by veins of ſandſtone.

Argillite with numerous ſhells is found in the iſland of Arran, and in the iſland of Eigg.

Basalt. This rock, which, as we have before obſerved, is peculiar to the Flotzgeburge, is found in almoſt every part of Scotland, either in ſtrata, or in veins. I obſerved it diſpoſed in ſtrata in the iſland of Seil, at Oban, in the iſlands of Mull,

 Eigg,

Eigg, Canna, and Skye; and theſe ſtrata either alternate with argillaceous ſandſtone, wacken, or greenſtone. Frequently alſo veins of baſalt traverſe theſe ſtrata.

Basalt Veins. Theſe veins are extremely common in moſt of the Hebrides, but are rarely to be obſerved in the Shetland or Orkney iſlands. I obſerved them traverſing granite, gneiſs, micaceous ſhiſtus, ſienite, porphyry, hornblende ſlate, ſandſtone, and limeſtone. In the iſland of Arran there are ſeveral very remarkable veins which are partly formed of baſalt. Thus in Glencloy there is a vein, (traverſing clay porphyry), which is compoſed of baſalt in the middle, but, upon one ſide is ſandſtone breccia, and, on the other is hard ſiliceous ſandſtone. At Tormore, upon the weſt ſide of the iſland of Arran, there are ſeveral other very remarkable veins partly formed of baſalt.

Basalt Tuff. I obſerved this rock at Dumbarton caſtle, and in the iſlands of Mull and Canna, where it always accompanies rocks of trap formation. In the iſland of Canna it is remarkable for having pieces of wood incloſed.

Pitchstone. This curious foſſil is found very frequently in the

the iſland of Arran, but generally in the form of veins. Theſe veins traverſe the common argillaceous ſandſtone, and are often of great magnitude. It is alſo diſpoſed in ſtratified veins along with other ſubſtances at Tormore in Arran. In the iſland of Mull it ſeems to lie between ſandſtone and baſalt; but in Eigg it forms conſiderable veins traverſing baſalt. This foſſil, which was before conſidered as very rare, is thus ſhewn not to be ſo uncommon; and I have lately learned that it has been obſerved in veins traverſing ſandſtone in Morven, and in veins traverſing baſalt at Ardnamurchan.

Greenstone. The country between the primary ſtrata at Dunkeld, and the banks of the Frith of Forth preſents many appearances of flotz greenſtone; and, in the ſame tract there is alſo wacken of a ſimilar formation.

Coal. In the iſland of Arran there is a ſtratum of blind coal incloſed in ſandſtone. In Mull, Eigg, Canna, Skye, it is obſerved always ſtratified with baſalt or wacken.

VOLCANIC ROCKS *

have never been difcovered in Scotland.

ALLUVIAL.

Of thefe there are examples in the Highland vallies, where the debris from the mountains are depofited in beds and covered by heath. The great banks of fand, and the immenfe beds of peat which we find fometimes alternating with beds of clay or fand, are of this kind.

MINE-

* Of the pfeudo-volcanic rocks, which are different fpecies of rocks that have been expofed to accidental fire, we have inftances in Fifefhire. Upon the fhore between Dyfart and Eafter Wemyfs I picked up feveral fine fpecimens of porcellanite, which feems to be the clay that accompanies the coal altered by fire, as maffes of fcoriæ and charcoal ftill adhered to it.

TO

JOHN WALKER, DD. MD.

FELLOW AND SECRETARY TO THE PHYSICAL CLASS

OF THE ROYAL SOCIETY,

REGIUS PROFESSOR OF NATURAL HISTORY,

AND

KEEPER OF THE MUSEUM OF THE UNIVERSITY

OF EDINBURGH;

THIS VOLUME,

OF THE

OUTLINE OF THE MINERALOGY OF THE SCOTTISH ISLES,

IS DEDICATED,

AS A TESTIMONY OF THE GREAT REGARD AND ESTEEM

OF HIS MUCH OBLIGED PUPIL,

AND OBEDIENT

HUMBLE SERVANT,

THE AUTHOR.

SHERIFF-BRAE, LEITH,
26. JULY, 1800.

MINERALOGY

OF THE

SCOTTISH ISLES.

CHAPTER I.

From Edinburgh, by Glaſgow, to the Craig of Ailſa.

IN travelling from Edinburgh to Glaſgow, by the Livingſtone road, the country continues, for a conſiderable way, pleaſant and well cultivated; but as we approach the Kirk of Shotts the ſcene is much altered. In place of incloſed fields, exhibiting the operations of thriving agriculture, extenſive moſs grounds appear, forming a ſtriking contraſt to the cultivated country through which we had juſt paſſed. Happily,

however, thefe moffes are now viewed in a more favourable light than heretofore: the brown burnt-like afpect of a peat moor does not now ftrike the mind with ideas of barenefs and fterility; as we know, from experience, that labour and a little expence may foon convert them into luxuriant fields.—A few miles after paffing this defert, we come in fight of Glafgow; but its low fituation, and the want of hills, render it, when compared with Edinburgh, far lefs interefting as a picturefque object. The nearer we approach the town the country improves, and is confiderably diverfified with wood and cultivated fields.

The rocks which occur in this tract are all of fecondary formation; which is commonly the cafe where the country is low and flat. As our journey was rapid, I can only fay, in general, that the ftrata are, fandftone, limeftone, bafalt, wacken, mandelftein, coal, with its accompanying fhiftofe clay, &c. and iron-ftone.

The fandftone is generally ufed for the purpofes of building; but, from different quarries it is more or lefs durable. This fact leads us to remark, that chemical trials, combined with correct mineralogical obfervations, might, in many inftances, enable us to determine, with fome certainty, as to the probable

probable durability of ftones employed in building. Indeed, thofe who have been long in the habit of analyfing and examining fuch ftones, can, even by their appearance, judge of their probable durability *: a circumftance fufficient to encourage us to purfue a mode of inveftigation which has hitherto engaged little attention.—The limeftone which occurs in this diftrict varies confiderably in its appearance: but we had not an opportunity of obferving it particularly. It is quarried in feveral places to a confiderable extent, and then burnt, and ufed for manure, and for building. It is burnt for thefe purpofes in the common draw-kiln, which is ill conftructed, as there is not only a great wafte of heat, but, by expofure to all the variations of the weather, the burning is rendered precarious and uncertain. My father remedied thefe defects in a kiln which he built eight years ago, and which he ftill continues

* We have a curious inftance of this related of the late Mr Bayen; a gentleman who had paid much attention to the genera of marble and ferpentine. Walking one day in the Place de la Revolution, at Paris, with his friend and colleague Deyeux, he pointed out to him feveral of the marble pillars, which, he faid, notwithftanding their prefent folid appearance, would decay in a fhort time, and in the particular places he mentioned. Accordingly, a year had fcarcely elapfed when his prediction was fulfilled: many of the pillars began to decay, and even confiderable hollows were quickly formed in fome of them.—*Annales de Chymie.*

nues to ufe as economical, both with regard to time and fuel. It differs from the common kiln by having the body or cylindrical part very deep, and covered with a dome, which is connected with a vent that has a damping plate, fo as to allow a very advantageous management of the heat. Befides, it has another very confiderable advantage over the common kiln, that is, it can be erected in a town without detriment to the neighbourhood, as all the noxious matter is carried away by means of the chimney †.

The country in the neighbourhood of Glafgow, as far as I had an opportunity of examining, is compofed, 1ft, of bafalt, which

† A vulgar prejudice has long prevailed, that the noxious matter of limeftone is more dangerous than that of common coal; and the many horrid ftories on record, of fudden deaths in the neighbourhood of lime-kilns, ftill continue the delufion with the ignorant.—The modern chemical difcoveries have fhown, that common coal, bulk for bulk, furnifhes more of the noxious matter (carbonic acid and carbonated hydrogen) than limeftone: therefore, the noxious effects of the common kiln does not depend on any peculiar malignity of the vapour which iffues from the ftone, but upon the conftruction of the furnace.

The patriotic Count Rumford has lately propofed a new plan of a lime-kiln, which certainly deferves to be tried: To us it appears objectionable, not only from the clofe attendance that the fires require, but alfo that a confiderable portion of heat is loft by its being open at top.—See *Rumford's Effays*.

which has ſometimes in-lying cryſtals of felſpar, baſaltic hornblende, augit, leucit, mica, and a few interſperſed particles of quartz; 2. baſalt porphyry; 3. grunſtein; 4. limeſtone. The ſhort time I could afford to ſpend in Glaſgow, and my anxiety to get forward to the Iſlands, prevented me from examining the relation of the different ſtrata to each other; which, however, I the leſs regret, as that circumſtance is but ſlightly connected with my preſent object.

Profeſſor Faujas de St. Fond has given us a ſhort account of the mineralogy of the environs of Glaſgow; but his deſcriptions are unluckily obſcured by a rigid adherence to a theory which has no foundation in nature. He conſiders all the rocks we have now mentioned, as lavas; and thoſe he denominates baſaltic, porphyritic, and granitic lavas. I do not heſitate a moment in ſaying, that, in my opinion, there is not in all Scotland the veſtige of a volcano. I do not reſt this aſſertion upon my own authority, (for that would be preſumptuous;) but upon that of Dr. Walker, who has examined more of the mineralogy of Scotland than any man now living, and whoſe collection of Scotch foſſils is the largeſt that has ever been made. Beſides, it wars with every principle of ſyſtematic claſſification, to arrange and denominate foſſils from any *theory* we may adopt as to their formation.

We

We now purfued our journey from Glafgow to Greenock, down the river Clyde: a voyage which prefents the traveller with many fcenes of uncommon beauty. At Glafgow the river is narrow, with low formal banks; but as we approach Dumbarton, the river becomes wider, the country more beautiful, and the fcene is foon rendered interefting by the appearance of the fingular rock of Dumbarton. From this the mountains of Cowal extend, along the north fide of the river, to Rofneath; forming a fine contraft of Alpine wildnefs, with the comparatively low green hills which reach to Greenock upon the fouth fide of the river. The ftrata between Glafgow and Greenock, upon the fouth bank of the river, are, fandftone, limeftone, bafalt, and wacken. Thofe of the north bank, to the town of Dumbarton, continue to be nearly of fimilar rock; forming, in this rout, fome confiderable heights, particularly about Frifky Hall, where the rocks have a fine terraced appearance. Immediately below the houfe of Frifky, at the porter's lodge, we obferved a fmall quarry of wacken, which is now celebrated as affording fine fpecimens of prehnite. The town of Dumbarton is fituated in a plain of confiderable extent; and the rock upon which the caftle is built, rifes from it in a fimilar manner with Arthur's Seat, near Edinburgh, but is much more ftriking, from the great flatnefs of the country. It is compofed of black bafalt; but, upon the fide facing the town,

we

we obferved a bafalt tuff covered by fandftone. Profeffor St. Fond remarks that this rock is formed of a black bafaltic lava; but upon the lower part, facing the town, there is to be obferved a current of muddy lava, having, intermixed, fragments of bafalt, more or lefs altered.—At different periods the rock of Dumbarton has been of confiderable confequence, on account of the ftrong fortrefs which is built upon it. When Mary, the unfortunate and lovely Queen of Scotland, was imprifoned in England, and her kingdom wrefted from her, the folitary rock of Dumbarton held out againft every attempt to take it; and was the only place in the kingdom that dared to acknowledge her authority.

If we glance over the country as it extends towards Lochlomond, we obferve it rifing gradually until the profpect is bounded by vaft mountains, marking, by their height and fhape, a change in the nature of the ftrata, and forming the grand entrance into the Highlands upon this fide of Scotland. If we examine the country more particularly, we find our conjecture right; for at Lufs, upon the banks of this beautiful loch, ftrata of micaceous fhiftus, and other primitive rocks, make their appearance. Thefe ftrata extend towards the Clyde, and form a confiderable part of its north bank, from Dumbarton to Rofneath, a fmall village oppofite to Greenock.

Greenock,

Greenock, a populous and flouriſhing town, is ſituated upon the ſide of the river, at the bottom of hills of conſiderable height; and remarkable for the quantity of rain which falls during the year, which is ſaid to be more than in any other part of Scotland. The ſtrata in the immediate vicinity of the town are, baſalt, wacken, ſandſtone, limeſtone: and in ſome places the ſandſtone is to be obſerved traverſed with baſaltic veins; and the wacken, beſides zeolite, contains a curious foſſil nearly allied to leucit.

From Greenock our farther progreſs down the Clyde was more intereſting, from the grandeur and variety of the objects which now occupied our attention. After paſſing the Gouroch lighthouſe, we obſerved the beautiful iſland of Bute, with the neighbouring and Cumbray iſles ſtretching acroſs the view; and, farther diſtant, the wild mountains of Arran appeared over the low part of Bute towering among the clouds. The hills upon the oppoſite bank of the river are ſtrikingly contraſted. Upon the Cowal ſhore the country riſes into conſiderable hills of micaceous ſhiſtus, which are partly heath-clad, and join with the bare and ſterile mountains that extend from this ſhore through Argyleſhire. Upon the oppoſite bank of the river the country is much lower; there are no ſteep hills upon the ſhore; and the ſtrata, which are horizontal, are, red and white

white-coloured argillaceous ſandſtone, ſandſtone breccia, baſalt, and frequently baſaltic veins traverſe both theſe ſtrata. The breccia, as is often the caſe with this kind of rock when it occurs upon the ſea-ſhore, forms beautifully wooded cliffs, which extend to the ſweetly-retired village of the Largs. Theſe ſecondary ſtrata extend from the Largs to Saltcoats, and from thence far through Ayrſhire; while the primary rocks, on the oppoſite bank of the river, appear to extend to the Mull of Cantyre.—In a few hours after paſſing the Cumbray iſles, and the majeſtic iſland of Arran, we landed upon the great rock which is called

The Craig of Ailsa.

This ſtupendous rock is ſaid to be 400 feet high, and is about two miles in circumference. It is ſomewhat of a conical ſhape, and very precipitous on all ſides: the only landing-place being on the N. E. where there is a ſmall beach, formed by the fragments which have fallen from the neighbouring rocks. It is much lower now than it was formerly; as is evinced, not only by the numerous fragments lying on the beach, but alſo more fully by the nature of the bottom near it, which, according to the moſt accurate ſoundings, is gravelly to a conſiderable diſtance.

After having walked around part of it, and aſcended near to the ſummit, I was forced to return, as the captain of the veſſel was anxious to proceed to Arran. On this account, I was prevented from examining it ſo accurately as could have been wiſhed. This glance, however, was ſufficient to ſatisfy me as to the general nature of the rock of which it was compoſed.

The greater part ſeems to be formed of different ſpecies of very compact ſienite; which, particularly on the eaſt ſide, preſents immenſe groupes of columns, ſimilar in appearance to the baſaltic columns that occur ſo often in different parts of Scotland. In aſcending towards the ſummit, and a little below the ſolitary ruin of a caſtle, I obſerved two conſiderable baſaltic veins traverſing the ſienite.

CHAP.

CHAP. II.

Deſcription of the Fossils *mentioned in the preceding Chapter.*

PREHNITE—*Friſky-Hall.*

Silex Prehnites, Wern. *Halb Zeolith*, Eſthner. *Bostrichites*, Dr. Walker.

It is either in flat maſſes, cellular, or botroidal, or partly aſſuming a mammillary figure; is generally radiated and compoſed of ſmall priſmatic cryſtals—ſometimes ſo ſmall, and ſo near to each other, as to aſſume, in ſome degree, a compact texture, almoſt reſembling chalcedony.

Colour. Varies, from apple green, to yellowiſh green, pale yellow, and white; but, when affected by the weather, it acquires an ochry, or opaque white colour.

Luſtre. The external luſtre little glancing*; internal is pearly.

Tranſparency. It is ſemi-tranſparent; but, when acted upon by the weather, it becomes conſiderably opaque, and much reſembles certain ſpecies of ſulphat of barytes.

Hardneſs. Gives ſparks with ſteel; takes a pretty good poliſh.

* *Wenig glänzend.* Germ.

Fracture. The fracture in the direction of the foliæ appears foliated, but acroſs the radii approaches to the conchoidal.

Fuſibility. Dr. Hope melted it, and, by ſlow cooling, had again a pretty regular cryſtalline texture.

It is contained in a ſpecies of wacken, which, by its degree of induration, appears paſſing to the ſtate of baſalt. It is frequently accompanied by calcareous ſpar. Another ſubſtance is often found with it, which is probably of the nature of zeolite.

It is formed of long priſmatic radii, which have the following character.

Colour. White.
Luſtre. Pearly.
Tranſparency. Nearly tranſparent.
Hardneſs. Difficultly ſcratched with a knife.

OBSERVATIONS.

The Prehnite has received many denominations, by different mineralogiſts: thus it has been called green felſpar, apple-green quartz, ſiliceous zeolith, cape-chryſolith, emerald, praſe, and cryſopraſe:—a ſtriking proof of the imperfection of mineralogical nomenclature. The juſtly-celebrated Mr. Werner, to whom

whom we owe fo much of our moft accurate information, names it Prehnite, after Colonel Prehn, a Dutch officer, who found it at the Cape of Good Hope, and firft brought it to Europe. Since its difcovery at the Cape of Good Hope, it has alfo been found in Dauphiné; and Dr. Grofcke of Mittau firft difcovered it at Frifky-Hall. This is not the only place in Scotland where this beautiful foffil is found; for I have obferved it in the caftle rock and Arthur's Seat at Edinburgh, and we fhall afterwards notice it in the ifland of Mull.

LEUCIT—*Greenock.*

Sarcite, Dr. Townfon's Tracts in natural hiftory. *Borax Margodes*, Lin.?

This foffil is of a reddifh-brown colour, and generally cryftallifed in the form of a 24 edron: it is alfo, in fome inftances, amorphous, with an earthy fracture *.

It has always occurred opaque, and of fuch a hardnefs as to yield with difficulty to the knife.

With the blow-pipe it lofes its colour, and melts like felfpar.

It

* Dr. Hope has in his poffeffion a very fine fpecimen of this foffil, which he found at the Calton Hill. Dr. Townfon has figured it in his Tracts.

It is found in the cavities of wacken, and ſometimes imbedded in calcareous ſpar.

Abbé Huay remarks that this foſſil is conſidered as a zeolite †; and La Metherie, who had examined ſpecimens of a ſimilar foſſil from the Calton-Hill at Edinburgh, remarks, " On " trouve, au mont Calton-Hill, proche d'Edimbourg, un cri- " ſtal à vingt-quatre facettes trapezoidales, comme celui-ci. " Il eſt rougeatre, poreux, terne, comme de la brique.—On " croit qu'il doit entrer dans la zéolite leucitique ‡." Dr. Townſon, in his lately-publiſhed Tracts in natural hiſtory, conſiders it as a new genus, and names it Sarcite: this, however, cannot be admitted, until the foſſil ſhall be regularly analyſed. Mr. Camara of Liſbon, a moſt intelligent mineralogiſt, informed me, that he had frequently met with this foſſil in other countries, but always conſidered it as nearly allied to leucit. It appears, then, that it ſhould ſtill be reckoned of the nature of leucit, until it ſhall be more particularly examined in the way of chemical analyſis.

SIENITE—

† Annales de Chymie.

‡ Th orie de la Terre, tom. 2de, p. 308.

SIENITE—*Craig of Ailſa.*

CALOMACHUS, Dr. Walker's Claſſes Foſſilium.

So far as I can determine at preſent, this rock appears to be a very compact ſpecies of ſienite, in which the felſpar is the moſt prevalent ingredient. Sometimes the felſpar ſeems paſſing to the ſtate of earthy felſpar; and then it forms a baſis in which we obſerve red or white-coloured cryſtals of common felſpar and hornblende, and particles of quartz: thus forming a ſpecies of ſienitic porphyry.

ARRAN.

A R R A N.

C H A P. III.

Size and Situation of the Iſland. Cliffs, Mountains, Surface, &c. Brodick Bay, and its Environs; comprehending Cory-Gills, Glen-Cloy, Glen-Shirreg, Goatfield, and Glen-Roſa.

THIS iſland is about thirty-two miles long and twelve broad; ſituated in the mouth of the Frith of Clyde, about eight miles from Bute, and ſixteen from Saltcoats in Ayrſhire. Its ſhape is irregular, but not ſo much ſo as many of the Weſtern Iſlands which are expoſed to the Atlantic Ocean. Here, the vicinity of the Scottiſh and Iriſh ſhores prevents any great deſtruction of land; as is evident from the lowneſs of the cliffs round the iſland, which have not the precipitous, rugged and bold aſpect of many of the Weſtern Iſlands.

Cliffs. The cliffs are ſeldom above two hundred feet high; are generally precipitous: having frequently, however, an intervening


THE
ISLAND of ARRAN,
Engraved for an Outline
of its
MINERALOGY
The route thro' the Island mark'd
Cock
Loch ranza
Tunderguy
Whitefarland
Imachar
Loch Tenna
Cory
Machry Bay
Machry
Brodick Bay
The String
Tormore
Glen Clachen
Glen Cloy
Corygills
Rue Varry
Drummadoon
Drummadoon Bay
Clachland
Clachland I.
Lamlash
Lamlash Bay
Lamlash or Holy Island
Kings Corse
Whiting Bay
Kilmorie
Torylin
Larrymenoch
Bennen Hd
Light House
Plada I.

tervening bank between the cliff and the ſea, formed by the deſtruction of the rocks, which are either of ſandſtone or micaceous ſhiſtus. Conſiderable ſandy beaches frequently occur, formed of the debris of granite, ſandſtone, and micaceous ſhiſtus; and ſometimes we remark a conſiderable extent of coaſt covered with enormous maſſes, which have been torn away by torrents, or ſeparated from the neighbouring rocks by the vaſt expanſive power of froſt.

Mountains. No regular ridge of mountains is to be obſerved: theſe being either in the form of groups, as Goatfield and the adjacent mountains, which preſent aſtoniſhingly grand peaked ſummits; or irregular, forming round-backed hills, as thoſe towards the ſouth part of the iſland.

Surface. The land is in general very high, particularly towards the north end, where the wonderful group compoſed of Goatfield, Caime-na-callich, &c. preſent mountains near 3000 feet high. Here Nature exhibits to the aſtoniſhed eye the moſt terrific and ſublime ſcenery; to convey even a faint idea of which would require an able pen. The ſouthern parts are lower; and in place of the bare rocky appearance of the north, we have heath-covered hills, and a conſiderable portion of cultivated land.

The iſland is divided into two pariſhes, Kilbride and Kilmory, belonging to three proprietors; the Duke of Hamilton, Marquis of Bute, and John Fullerton, Eſq. of Kilmichael; and yields about 5000 l. of yearly rent. This indeed might be much increaſed, were proper methods of cultivation followed; and were long leaſes and larger farms properly granted, more happineſs, induſtry and wealth would be the natural conſequence.

In deſcribing the iſland particularly, I ſhall begin with

Brodick Bay, ſituated on the eaſt ſide. This beautiful bay is bounded, on the S. by the hills of Cory-gills; on the W. by the vales of Glencloy and Glenſhirreg, and, on the N. the tremendous Goatfield forms a lofty boundary. It is of an irregular ſhape; about five miles long, and four broad; having about five fathoms water, with good anchorage ground: but it is only in moderate weather that veſſels can ride in ſafety. From this bay paſſage-boats go to Saltcoats, about ſixteen or eighteen miles diſtant, which renders this the principal thorough-fare in the iſland; ſo that the population is conſiderable. Many viſitors come from the mainland, during the ſummer months, to enjoy the free air, and admire the wonderful ſcenery of this intereſting iſland: but the want of a good inn is much to be regretted.

regretted. On the north ſide of the bay ſtands Brodick Caſtle, an old ruinous building, inhabited occaſionally during part of the ſummer by the Duke of Hamilton. It is ſituated upon the ſide of Goatfield, commanding a moſt extenſive and delightful proſpect; and might eaſily be made a beautiful ſeat. About two miles diſtant, in Glencloy, is ſituated the pleaſant ſeat of the worthy and moſt hoſpitable family of Fullerton, of Kilmichael, who have now reſided in the iſland upwards of 700 years.

Mineralogy. The mineral hiſtory of this part of the iſland is, in many reſpects, intereſting; not only on account of the variety of foſſils which it affords, but alſo in preſenting to us, in a ſhort ſpace, a repreſentation of the ſtructure and materials of nearly the whole iſland. On this account I ſhall be minute in my deſcription; as I may have occaſion to refer to this particular part, when deſcribing the other quarters of the iſland.

The ſouth ſide of the bay is low immediately upon the ſhore: it however riſes gradually; forming the hills in the neighbourhood of Cory-gills, and, towards the ſea, cliffs of conſiderable height, almoſt entirely compoſed of ſandſtone *. This ſandſtone

* M. de C. Laſſone has obſerved, that the ſurface of a ſandſtone, which had the

stone is pretty compact, of a reddish colour, much resembling that found in Shetland; and is here and there alternated with strata of breccia, composed of rounded fragments of quartz, with fragments of sandstone, of various sizes and shapes; and both these strata run at an angle of from 10° to 15°. In many places there are very considerable veins of basalt, or what have been called Whin-dykes †, crossing the sandstone in various

the year before been left uncovered, was invested with a siliceous crust, nearly as hard as agate: the particles of which it was formed must therefore have been conveyed and deposited by water. *Mem.* Par. 1774. *Kirwan's Geological Essays*, p. 112.—This is a proof of the solubility of siliceous earth in water: a fact denied by the Plutonists. It is more demonstrably confirmed by the following fact, from Mr. Kirwan's Geological Essays, p. 140. "About the year 1760, the Emperor "of Germany being desirous to know the length of time necessary to complete a "petrifaction, obtained leave from the Sultan to take up and examine one of the "timbers of Trajan's bridge over the Danube at Belgrade. It was found to have "been converted into agate to the depth only of half an inch; the inner parts "were slightly petrified, and the central still wood."

† The term Whinstone, like many other popular denominations, does not convey a distinct idea of any particular genus of fossils; but is used by the inhabitants of Scotland, and of the north of England, to express those fossils which are of *trap formation*. Mineralogists, in many instances, appear to have used it in a very vague manner: thus some describe trap, others basalt; and not unfrequently wacken, greenstone and indurated clay have been arranged under this name.

rious directions. Some may be obferved rifing from the fea, and penetrating the fandftone. In other places, where the fuperincumbent fandftone has been completely carried away, veins can be remarked running, with little variation in diameter or direction, for nearly a mile. Thefe veins are not only to be obferved upon the fea fhore, but can be traced running, in various directions, and of different diameters, through the fandftone and other rocks in the interior of the ifland, as we fhall afterwards clearly demonftrate. In afcending the hill towards Cory-gills, a very confiderable vein of dark leek-green pitchftone makes its appearance, running from the cliffs upon the fhore, thro' the fandftone, to the Lamlafh road, where we foon lofe it among the fandftone in the neighbouring hills. This vein is of various breadths; in fome places, as at the Lamlafh road, being about eight feet. It does not appear to have altered the fandftone, where it is in contact with it; but, in fome parts of the vein, the pitchftone, as it approaches the fandftone, lofes much of its luftre, and, in fracture and hardnefs, approaches to the nature of bafalt.

The

name. It is much to be wifhed that it could be entirely laid afide; particularly when we perceive that the great Werner has framed fatisfactory characters for thefe different rocks.

The appearence of pitchſtone in the form of veins, and in ſecondary ſtrata, has not as yet been obſerved by other mineralogiſts. Mr. Werner, from his own extenſive knowledge, and the accummulated information of his numerous pupils, is of opinion, that pitchſtone is always diſpoſed in ſtrata, and entirely confined to primitive mountains. The late Abbé Spallanzani deſcribes ſeveral veins of pitchſtone lava that he obſerved in the Euganean mountains; but it is difficult to determine with certainty whether this be the true pitchſtone *.

Higher up, above the houſes of Cory-gills, I obſerved a number of columns which are compoſed of clay-porphyry. Theſe pillars are in various directions: ſome are perpendicular to the horizon; others more or leſs inclined; and I obſerved, farther up, that they are quite horizontal. They are in the form of four or ſix-ſided columns, from ſix to ten feet long, and two or three feet in diameter, having a whitiſh cruſt from decompoſition. They are not jointed; nor is there any appearance of balls, or what the volcaniſts call *volcanic bombs*. I endeavoured to diſcover the poſition of the porphyry with regard to the ſandſtone, but could not detect them in contact with each other; yet, from the nature of the rocks all

* Spallanzani's Travels in the Two Sicilies, vol. 3d, p. 251, &c.

all around, I am inclined to believe that it refts on the fand-ftone. In defcending from this porphyry hill towards Lam-lafh, the fandftone again makes its appearance, but is foon loft; being covered with a rock which is principally compofed of dark-green coloured hornblende, with a little felfpar and quartz, and anfwers nearly to the greenftone of the Germans. This greenftone forms the fummits of feveral hills in the neighbourhood, and may be remarked running towards the fea, forming high cliffs. In one place I obferved a great body of green-coloured pitchftone, which runs quite in an oppofite direction to the vein I obferved croffing the Lam-lafh road: in fhort, it appears to be ftratified, and to run immediately below the greenftone. About twenty yards lower, another mafs occurs, about ten or twelve feet thick; and which, fo far as I could determine, appears to form a ftratum, running between the fandftone and greenftone. I was inform-ed that this mafs of pitchftone had been traced to the face of a high cliff upon the fea-fhore, where it is faid to lie upon fand-ftone, which alfo covers it; and that it was there alfo fplit into columns, like bafalt.

Having now mentioned the pofition of the veins and ftrata upon the fouth fide; I fhall return to the fea-fhore, where we obferve

obſerve the bay riſing towards the weſt, forming the one ſide of Glencloy.

Glen-Cloy. This glen is nearly three miles long, and half a mile broad; open towards the eaſt, but bounded on the other ſides by high hills. At the top, or weſt part, of the glen, the hills are higheſt, forming a very romantic groupe of rocks. The north and ſouth ſides, which are of conſiderable height, become gradually lower as they approach the ſea, where they form part of Brodick Bay. The bottom of the glen riſes gently from the ſea, forming a ſmall angle with the hills that bound it. Immediately under the peat moſs, or heather, we diſcover boulder ſtones, which form a thick bed, from three to thirty feet thick; and in other places they are collected together in heaps, being thrown into this form by the force of water. Theſe bowlder ſtones are not of very conſiderable ſize, and vary but little in that reſpect at the top or bottom of the glen; which ſhews that the greater part of them have not received their rounded form by attrition in the water of the glen, but are derived from decompoſed breccia. They conſiſt of granite, porphyry, ſienite, breccia and ſandſtone, which are all to be obſerved in the neighbouring hills. Through the glen runs Glencloy burn, formed by the ſprings and rains from the

the

the hills: it is narrow, but, during violent ftorms, it overflows a confiderable part of the glen, and has thus laid bare the rocks, and fhows us, in a fatisfactory manner, the nature of the fubjacent ftrata. The bottom of the glen is compofed of the common red-coloured argillaceous fandftone, and here and there are ftrata of breccia; and both are traverfed with veins of bafalt, which run in very various directions, and are from three to twelve feet in breadth. Thefe veins, in their paffage thro' the ftrata, (to ufe the Huttonian language,) do not appear to have occafioned in them any alteration with regard to hardnefs: on the contrary, we often find a fpecies of femindurated clay interpofed between the fandftone and bafalt, thus forming a ftratified vein.

Reufs, the celebrated German geologift, in his mineralogical hiftory of Bohemia, defcribes two ftratified veins which he obferved in the Bunzlauer circle. As it is of importance to turn the attention of the young mineralogift to thofe curious, and, I believe, rare, appearances, I will fhortly mention the nature of thofe veins obferved by Reufs. One of the veins traverfes argillaceous fandftone, and is about a fathom wide; its fides are of common argillaceous ironftone, about five or fix inches wide: to this fucceeds a layer of wacken-clay, about half a foot wide; then a thin layer of wacken, or rather a rock

intermediate between wacken-clay and wacken; laſtly, the middle of the vein is baſalt. The other vein has argillaceous ironſtone for the *ſaalband* or ſides, but the middle is wacken clay. The ſandſtone, as it comes in contact with the vein, is remarkably great-grained and iron-ſhort *.

The hills on the north and ſouth ſides of the glen are of the ſame height; and the pente of the hills appears to correſpond pretty nearly with the elevation of the ſtrata. The hills on the ſouth ſide are formed of ſandſtone and breccia, which, towards the upper end, form very lofty precipices. Many veins of baſalt traverſe the ſandſtone, and looſe nodules of browniſh-black and black pitchſtone lie ſcattered about here and there. On the north ſide of the glen, near to Brodick wood, a conſiderable body of dark leek-green coloured pitchſtone makes its appearance; but it is ſo much covered with graſs, that it is difficult to ſay whether it forms a vein or a ſtratum. It is well worthy the attention of thoſe who may viſit Arran, to endeavour to determine this point. In aſcending the hills upon this ſide, after gaining a conſiderable height, the ſandſtone diſappears, when a clay

* Mineralogiſche Geographie von Bóhmen, von Franz Ambros Reuſs, Vol. 2.

a clay-porphyry is to be obferved; and upon the brow of the hill, where the rains, &c. have broken down the porphyry, feveral curious phenomena appear. In the firft place, I obferved the porphyry in columns fimilar to thofe at Corygills: next, the bafaltic veins running in different directions through it. One great vein is to be obferved rifing from the neighbouring fandftone, penetrating the clay-porphyry; and, as it rifes upwards, getting a confiderable curve, when it branches: one branch rifes to the top of the hill; the other runs but for a fhort way into the porphyry, in the form of a wedge. Near to the fame place a curious *ftratified* vein makes its appearance, running in an almoft oppofite direction to that we have juft mentioned, and terminating in a wedge-like form. On the upper fide it is formed of fandftone breccia; the lower is hard filiceous fandftone; but the middle is bafalt.—The weft or upper end of the glen is formed of fandftone pretty much traverfed with veins of bafalt, which are more or lefs inclined, and of various diameters. Befides this fandftone, we obferve lofty precipices of fienite, which form ftrata elevated at an angle of about 30°. This rock is not only very much varied in the nature of its conftituent parts, but alfo in the degree of intimacy of combination, which renders it very difficult to diftinguifh its different fpecies. It is alfo traverfed with

veins of bafalt, but not fo much fo as the fandftone *. It forms the higher part of feveral of the hills betwixt the top of this glen and the Shifkin, and is all along traverfed with bafaltic veins.

It appears, from the defcription that has been now given, that the fandftone forms by far the greateft part of the glen; the next in proportion is the porphyry, and laftly the fienite.

The

* Dr. Hutton, in his fpeculations upon the theory of the earth, remarks, "If it be by means of heat and fufion that ftrata have been confolidated, then, "in proportion to the degree of confolidation they have undergone from their "original ftate, they fhould, *cæteris paribus*, abound with more feparations in the "mafs. But the conclufion is found confiftent with appearances. A ftratum of "fandftone does not abound fo much with cutters and veins as a fimilar ftratum "of marble, or even a fimilar ftratum of fandftone that is more confolidated: "they are in general interfected with veins and cutters; and in proportion as "ftrata are deep in their perpendicular fection, the veins are wide, and placed at "greater diftances." This does not appear to be confiftent with the fact; for it is to be obferved, in Arran, that the fandftone contains more veins than the fienite, which laft is harder than any fandftone in the ifland; and we obferve that the fienite contains a greater number of veins than the granite, although it be fofter and lefs compact.

The determination of the relative pofition of ftrata and veins is the great object of the geologift, and without it his labours will be of comparatively little value. It is, no doubt, of importance to know that a country is compofed of particular kinds of rock: yet this will be very unfatisfactory, if we know not whether thefe rocks be primary or fecondary, how they lie with regard to each other, and, confequently, if they be favourable for the appearance of metallic veins, coal, &c. Many travellers, as my friend M. Camara de Bethencourt has obferved †, fatisfy themfelves, in their geological obfervations, by following a very fuperficial and abfurd mode of inveftigation. Thus, fome are contented to fit in their carriage and view the rocks as they pafs along; others, with more apparent curiofity, examine the debris at the bottom of the hills, and, by means of their telefcopes, determine the nature of the higheft mountain. It is plain that thefe practices muft be very detrimental to the advancement of true geological knowledge: they are the more fo, when we confider, that the greateft labour and affiduity is often employed in vain to delineate the true geological character of fome parts of a country. In the courfe of my limited travels I have experienced the truth of this obfervation; for, after having fpent many days in endeavouring to deter-

mine

† Neues Bergmannifches Journal. B. i. § 272.

mine the relative pofition of certain ftrata to each other, I have been obliged to reft fatisfied with a general conclufion drawn from the nature of the furrounding rocks. Thus, in Glencloy, I could not difcover the porphyry and fandftone at their junction; yet, if we confider that the porphyry, both here and at Corygills, is found upon the fummit of fandftone hills, and that, in this place, we obferve the fame bafaltic vein apparently traverfing the fandftone and porphyry, we may prefume that they are of the fame formation, and that the porphyry covers the fandftone. We have more certainty with regard to the fienite, which appears to be of an origin anterior to the fandftone; as is pretty well fhewn from the appearance of a breccia that lies upon its furface, which had been interpofed between it and the fandftone, before the caufes which formed the glen had removed the fandftone.

Glenshirreg. This glen is of confiderable extent, bounded upon one hand by Glencloy, and on the other by Glenrofa. The hills towards the W. are not fo rugged as thofe at the top of Glencloy, and both the bottom and fides are formed of the common fandftone, much traverfed with veins of bafalt; but towards the S. W. we obferve a clay-porphyry, which forms part of the rocks higher up than the fandftone, and is, in fact, part of the mafs we obferved before in Glencloy.

Goatfield.

Goatfield. This mountain, according to Profeſſor Playfair, is about 2945 feet above the level of the ſea, and is reckoned the higheſt in the iſland. It riſes pretty rapidly from the ſouth ſide of Brodick Bay, until we arrive at the region where the micaceous ſhiſtus diſappears. At this height there is a kind of irregular plain, from which the mountain riſes in the form of an obtuſe pyramid, and is very precipitous, being entirely formed of granite. On the W. where it forms part of Glenroſa, it is extremely ſteep, which is owing in a great meaſure to the want of micaceous ſhiſtus and ſandſtone; for, in general, wherever theſe occur the declivity is leſs ſudden. On the eaſt ſide the pente is more gradual; marking, according to the ſteepneſs, the preſence of granite, micaceous ſhiſtus, or ſandſtone. It declines a little towards the N. but it riſes again, forming one of the boundaries of the rude Glen-Sanicks: it alſo forms the top of the bare, rugged and ſterile Cory-Glen, and the top of the other two great hollows between the Cory-Glen and Glen-Sanicks.

The lower part of Goatfield is compoſed of the uſual red-coloured ſandſtone, and is traverſed by veins of baſalt; this continues for ſeveral hundred feet up the mountain, when it at laſt diſappears: the micaceous ſhiſtus riſes from under it, ſeparated only by a ſtratum of breccia, thus ſhewing the relative

poſition

pofition of the fandftone and micaceous fhiftus. The micaceous fhiftus continues until we arrive at the plain formerly mentioned; but the fide of the mountain, in fome places, is fo covered with the debris of granite, micaceous fhiftus, &c. that it is only by the appearance of the granite, in the neighbourhood of this plain, that we are aware of its exiftence, as the afcent is hardly more fteep over the micaceous fhiftus than the fandftone, which is not generally the cafe; for we find, when the ftrata are not covered with debris, that the fandftone is far lefs fteep than the micaceous fhiftus, and this laft than granite. Even in this way, we have a kind of general rule for judging of the nature of mountainous ridges. If they be peaked, and very precipitous, we may prefume that they are of granite; if they be lefs lofty, and not peaked, but ftill fomewhat approaching to the conical fhape, we may fuppofe them to be compofed of micaceous fhiftus; and, laftly, if we obferve thefe fkirted by lower mountains, with a trifling pente, we may conclude that they are compofed of fandftone and limeftone. Although thefe obfervations may hold true in general, yet they will fometimes be found liable to confiderable variations: thus we know that the fhape, and other appearances, of mountains compofed of fimilar rocks, are apt to be varied by feveral circumftances, particularly by the horizontality or verticality of the ftrata, their degree of compactnefs, and their

aptnefs

aptnefs to be weathered. It would be an addition of fome confequence, if we had a few general rules on this fubject. Sauffure well remarks, " Les fignes qui peuvent donner " quelque indice de la nature des montagnes, à de grandes " diftances, et au travers des plantes qui les couvrent, font en " petit nombre, et meritent d'etre étudiés et confacrés par des " termes propres."

The pyramidal part of the mountain has a very fterile and wild afpect; being completely covered with loofe blocks of granite, and deftitute of all vegetation, excepting a few lichens, which only add to its bleak appearance. Thefe blocks differ very much in fize, fome being twenty feet long *, and generally of a quadrangular fhape; and are fo heaped upon each other, as to render the afcent very difficult. Having, however, gained the fummit, we are well repaid for our labour by a moft extenfive view of a wonderful diverfity of country. To the

E northward

* Dr. Walker has obferved immenfe folid maffes of granite in different parts of the Highlands: but thefe are vaftly inferior to others that have been found in other countries. About thirty miles from the Cape of Good Hope there is a large mafs of granite, called the Pearl Diamond, which is about half a mile in circumference, and 400 feet high. *Phil. Tranf.* 1778, p. 102.

northward we look down upon the peaked ſummits and deep glens in the neighbourhood of Goatfield, whoſe arid and reddiſh appearance ſuggeſts to our minds the effects of a dreadful conflagration. Beyond theſe, the iſthmus of Cantyre, the iſland of Iſla, the lofty and dreary paps of Jura, the long mountainous ridges of Argyleſhire, and the far-diſtant mountains of Mull, which are faintly deſcried, preſent a view rather to be felt than deſcribed. On the E. the well cultivated iſland of Bute, the frith of Clyde, the Cumbray Iſlands, backed with the beautiful coaſts of Renfrewſhire, form a moſt picturesque ſcene. Towards the S. we have, below us, the lower part of the iſland ſpread out like a map, forming a ſingular appearance of heath-covered mountains and cultivated glens: farther diſtant, the charming coaſts of Ayrſhire, the ſhores and mountains of Galloway, as far as the Mull, the ſtupendous craig of Ailſa, riſing from the boſom of the ocean, all delight the eye and raviſh the imagination. Laſtly, on the W. the coaſt of Ireland, from Fairhead to Belfaſt Loch, concludes the amazing view from this intereſting height.

Glenrosa. This very ſtriking glen, ſituated upon the weſt and ſouth-weſt ſides of Goatfield, is about five miles long, and half a mile broad, bounded by very high mountains. The bottom

bottom forms a confiderable angle with the fides, rifing gradually towards the upper, or north end, where it is formed partly by the mountain called Keid-voe, and partly by Goatfield. The mountains on the oppofite fides of the glen are of different heights, (being far higher on the eaft than weft;) but the inclination of the oppofite flopes is the fame, being about 70°. At its entrance upon the fhore at Brodick Bay, it has Goatfield on the north, and Glenfhirreg on the fouth. On the fouth fide, the ftrata are common argillaceous fandftone, traverfed by bafaltic veins; but this continues only for a fhort way, as the micaceous fhiftus foon makes its appearance. Upon the north fide, a very little fandftone is to be obferved at the bottom of the hill, the upper part being formed of micaceous fhiftus. Amongft the debris of the micaceous fhiftus I obferved great blocks of a rock, which is principally compofed of hornblende, and now and then intermixed with quartz, and a fubftance that appears to be the fame with the paliopetre of Sauffure. The micaceous rocks upon both fides of the glen lie upon granite, which foon prefents itfelf as we proceed up the glen, and forms the mountains upon both fides to its further extremity. This granite, which is fimilar to that of Goatfield, appears to be difperfed in great ftrata, that run N. and S. which is nearly in the direction of the glen. If we view them from

the bottom of the glen, they appear like great perpendicular walls, which are ſplit in many places into rhomboidal maſſes; but if we clamber upwards for ſome hundred feet, we at length diſcover the edges of the ſtrata, extending for a great way, and emerging here and there from above the looſe blocks of granite, which have fallen from the mountains, or have been formed by the ſplitting of the banks themſelves.

It was long believed, by geologiſts, that granite never occurred in ſtrata, but merely formed great maſſive mountains. This has been ſhown to be erroneous by many later obſervers; yet La Metherie, in the laſt edition of his Théorie de la Terre, ſpeaking of granite mountains, remarks, "Les maſſes ne ſont "ni par bancs, ni par couches, comme l'ont pretendu de ſa-"vans naturaliſtes. J'ai parcouru une grande quantité de ter-"reins primitifs, et je n'y ai jamais vu de couches. Quelque-"fois on appercoit des maſſes aſſez conſiderables de granites, "ayant une figure preſque rhomboidale, ſuperposés les uns "ſur les autres. Mais on ne ſauroit regarder ces ſuperpoſi-"tions pour des couches, puiſqu'elles n'ont rien de regulier, "et que ces maſſes, preſque rhomboidales, ne ſe rencontrent "que très rarement. Le plus ſouvent ces granites ſont fen-"dues, en differens ſens. Ces fiſſures ſe correſpondent

"quelque-

" quelquefois; ce qu'on prendroit, au prémier coup-d'œil, " pour des éſpèces de couches; mais un éxamèn plus appro- " fondi en fait bientôt reconnoitre la difference †." To theſe obſervations we will oppoſe that of ſeveral geologiſts who have obſerved ſtrata of granite, ſimilar, I imagine, to thoſe which occur in Arran, in different parts of Europe. The late celebrated M. Sauſſure, whoſe accuracy of obſervation is not to be queſtioned, diſcovered granite diſperſed in ſtrata in many parts of Europe; as may be ſeen by conſulting his moſt intereſting and elegant volumes. Reuſs, in his mineralogical geography of Bohemia, has detailed minutely many ſimilar appearances; and my learned friend Dr. Mitchell informs me, that the Reiſenbergs, a chain of mountains which ſeparate Sileſia from Bohemia, are compoſed of granite, for above fifty miles, and in this long courſe it is invariably diſpoſed in ſtrata nearly horizontal ‡.

Upon the eaſt ſide of the glen ſeveral curious appearances are to be obſerved. Of theſe, the moſt intereſting are the baſaltic veins,

† Tom. iv. p. 352.

‡ Mr. Kirwan, in his Geological Eſſays, refers to ſeveral other authors who deſcribe granite diſpoſed in ſtrata.

veins, which traverſe the granitical ſtrata, as they do the porphyry and ſandſtone *. The firſt vein which I diſcovered, being between three and four feet in diameter, is to be obſerved riſing through the granite, ſeveral hundred feet above the bottom of the glen. Its lower part is hid by the heather, and looſe blocks of granite, which cover the ſides of the mountains. As it riſes upwards it becomes gradually narrower, and at laſt divides into two branches, which run through the granite, contracting and enlarging their diameter from a few inches to more than two feet. The extremity of one of theſe branches appears either to have been broken, or ſo ſunk inwards as to cauſe one part of the branch to appear ſeparated from the other, as is repreſented in the plate; where A is the granite, B the baſalt vein, C the branch having the appearance of being ſeparated from D by intervening granite ‡. In the body of the great vein

* However commonly we obſerve baſaltic veins traverſing the granite in this iſland, yet it appears to be a rare occurrence in other countries. Reuſs never obſerved it in Bohemia; and Sauſſure, in a late communication to the Bibliotheque Britannique, aſſures us that he never obſerved any baſaltic rock among granite. *Bibl. Brit.* vol. vii.

‡ Rocks which are diſpoſed in ſtrata preſent ſimilar appearances with the vein above deſcribed, and of this we have a curious example in Saliſbury Craigs near Edinburgh. This hill, which is entirely compoſed of rocks of trap formation,

vein there is immerfed a confiderable wedge-fhaped piece of granite, marked in the plate at E; which has the ufual hardnefs, colour, &c. of that fpecies of which Goatfield is formed. The granite and bafalt are not intermixed at their junction; no matter is interpofed; and they are not altered in the leaft by being in contact with each other. In the neighbourhood of this vein were found fpecimens of rock cryftal in cavities of the granite; and fome of the cryftals were of confiderable fize, but generally of a fmoke colour. I alfo picked up a fpecies of granite fimilar to the pierre graphic which is found at Portfoy *; alfo a ftone much refem-

tion, affords fome fine views of its ftratification, in a lofty cliff that extends around a confiderable part of it. Towards the north extremity of this cliff, the red-coloured fandftone, which lies below the bafaltic rock, is much waved in its courfe, and, at one place, a part of the fandftone ftratum appears detached and immerfed in the bafaltic rock. The inclofed piece of fandftone is of great fize, ftill preferves its ftratified-like afpect, only it is very hard. Dr. Hutton reckons it a ftrong proof of the truth of his theory: but Mr. Deriabin, an intelligent mineralogift, who examined it along with me fome time ago, thinks, that the ftratum is not broken, only that it finks behind the bafalt, as I have conjectured may be the cafe with the vein above defcribed. Dr. Hope informs me that feveral fimilar appearances are to be obferved in the neighbourhood of Edinburgh.

* I found a fimilar rock among fome foffils fent me from Hudfon's Bay; and, by a late memoir of Patrin in the Bibliotheque Britannique, (vol. 8. p. 78.) it proved alfo to be a production of Corfica.

refembling the veined granite of M. Sauffure; and likewife a curious fpecies of granite, where the quartz, felfpar and mica were diftributed in a radiated form, as is the cafe with many zeolites.

Near to the fummit of Goatfield I picked up feveral pieces of rock, which is evidently the fame with the paliopetre of Sauffure, which he found loofe near to the fummit of Mont Blanc in Switzerland †. Lower down, but upon the fame fide of the glen, many fragments of bafalt are to be obferved, lying upon the fides of the mountains, fhowing the prefence of bafalt veins; and at the Keid-voe a great vein is to be feen, rifing perpendicularly through the granite. Nearly at the fame place, I was much furprifed to find feveral columns of dark leek-green coloured pitchftone lying amongft the debris of the granite; but, after confiderable labour, I was not able to difcover its fituation.

Not far diftant from this, in afcending towards the fummit of Goatfield, amongft the loofe blocks of granite which cover its fides, I obferved a curious appearance. Upon breaking

† Voyages dans les Alpes, tom. 7me, p. 275.

breaking thefe rocks, with an expectation of difcovering rock cryftal, I found in feveral of them maffes of compact granite, of different fizes, either rounded or angular. Somewhat fimilar appearances have been obferved by other mineralogifts: thus Mr. Werner has in his poffeffion a mafs of granite which contains pieces (gefchiebe) of gneifs *; Mr. Rofter found between Ellbogen and Schlackenwalde, in Bohemia, a great-grained granite †; and Mr. Sauffure obferved a mafs of granite which contained an oval piece of gneifs ‡. Mr. Werner reckons his fpecimen a proof that the gneifs is of earlier formation than the granite; in other words, that the pieces of gneifs have been broken off a ftratum which was depofited before the granite. Mr. Sauffure, however, is of an oppofite opinion: he is inclined to believe that thefe pieces of granite or gneifs have been formed fimultaneoufly; and that they have, by fome peculiar circumftance, affected a rounded form, which is not manifefted in the other parts of the rock. This conjecture is rendered more probable from the following fact: "I have of-" ten feen, fays he, in veined granite, rounded pieces of a far

* Werner, Kurze Klaffification der verfchiedenen Gebirgsarten.

† Emmerling Lehrbuch der Mineralogie. B. 3.

‡ Voyages dans les Alpes.

"finer grain, which neverthelefs had been formed fimultane-"oufly, fince we obferved the continuity of the layers of the "fine-grained, with that of the granite in great grain and "thick layers."

The weft fide of the glen is formed in part by a granitical mountain, named Ben-echleven, which prefents to us the great flat fides of the granitical ftrata. Its top is covered with enormous blocks of granite, which reft upon it in a moft fantaftical manner. This mountain declines rapidly towards the N. E. forming a tremendous hollow, named Cory-dain, whofe bottom is far elevated above that of Glenrofa, but is lower than the bottom of the next hollow, named the Feun-hody, which is raifed far above either, prefenting to the bewilder'd eye an amazing fcene of ridged and peaked rocks of granite. In the Cory-dain, the granite, at firft fight, appears to be ftratified horizontally; but an examination fhews us that is owing to the fplitting of the granite. Here alfo we obferve the granite difintegrating in the form of fand, and, what is more rare, decompofing in the manner of fome fpecies of bafalt, that is, in crufts *. Sauffure, fpeaking of this kind of decompofition, remarks:

* Granite decompofes in concentric layers.——Charpentier Mineralogifche Geographie der Churfachfichen Lande. § 31.

marks: "Un autre fait, dont je trouvai la ſolution en exami-
" nant ces granites de prés et avec attention, c'eſt celui de ces
" exfoliations que j'avois obſervées dans la vallée ſuperieure.
" C'eſt un fait connu de tous les minéralogiſtes, que la plupart
" des pierres ſont plus tendres dans le ſein des montagnes qu'à
" leur exterieur, et qu'elles acquierent à l'air un degré de
" dureté ſenſible. Il ſuit de-là, que la partie exterieure, ou le
" bord de la tranche verticale d'une grande aſſiſe de granite,
" doit ſe durcir par le contact de l'air, tandis que l'interieur
" de la meme aſſiſe conſerve un certain degré de molleſſe. Et
" tant que les aſſiſes inferieures demeurent un peu molles, le
" poids enorme de toutes celles qui repoſent ſur elles doit à la
" longue les comprimer. Mais les parties exterieures, durcies
" par le contact de l'air, ne ſont pas ſuſceptibles de la meme
" compreſſion. Elles doivent donc s'en ſeparer, et former ainſi
" les exfoliations que l'on obſerve *."

* Voyages dans les Alpes, tom. 6me, p. 318.

A R R A N.

CHAP. IV.

Defcription of the Fossils *mentioned in the preceding Chapter.*

PITCHSTONE.

Argilla Picea, Werner. *Retinite*, La Metherie. *Opalus Piceus*, Gmelin.

Pitchstone *from Lamlafh Road.*

Colour. Dark leek-green.

Luftre. Internally it is glancing *, with a waxy luftre ‡; is often beautifully iridefcent, and this is particularly the cafe at the thin edges of the fplinters.

Hardnefs. Gives a few feeble fparks with fteel, but is very brittle.

Fracture.

* Glänzend. ‡ Wachsglanz.

Fracture. More or lefs perfectly multiplied conchoidal, or fplintery; often fhiftofe; and rarely prefents diftinct concretions.

Fragments. Almoft always in the form of four-fided irregular columns.

Tranfparency. Tranfmits a very little light at the edges.

Fufibility. At 23° of Wedgewood's fcale, it becomes black, is much rent, and internally a little porous; at 55° it had formed a porous enamel; and at 70° it became perfectly white, and the enamel was little porous.

It frequently contains a few cryftals of white felfpar, which appear of the nature of adularia; and I obferve interfperfed grains, apparently of quartz. This fpecies is often intermixed with one fimilar to that obferved at Brodick wood.

PITCHSTONE—*Brodick Wood.*

Colour. Dark leek-green; but the number of diftinct concretions often give it a lighter hue.

Luftre. Little glancing *, with a greafy luftre ‡.

Tranfparency. Tranfmits a very little light at the edges.

Hardnefs.

* Wenig glänzend.

‡ Fett glanze.

Hardneſs. Gives a few ſparks with ſteel.

Fracture. Uneven, conchoidal, and ſometimes ſplintery, with numerous diſtinct concretions; in the groſs is often ſlaty.

It ſometimes contains cryſtals of white felſpar and quartz, cryſtalliſed in ſix-ſided pyramids.

It decompoſes, by the action of the weather, in the form of a white tegmen, which is often ſeparable into layers; and, by the decompoſition of the felſpar, it gets a cellular appearance, when it requires an experienced eye to diſtinguiſh it from ſome of the productions of Lipari. It is alſo frequently traverſed with another ſpecies, which has a greater degree of luſtre, and is more difficultly decompoſable by the action of the weather; ſo that ſpecimens of this kind, when decompoſing, preſent a ſtriped ſurface of dark-green and white, the dark-green being the undecompoſed ſpecies. Gerhard, in his Mineral Syſtem, mentions a ſpecies of gneiſs, or granite, that contains obſidian, a ſtone much allied to pitchſtone. Dr. Townſon, in his Travels through Hungary, remarks, that this gneiſs is a ſpecies of obſidian, with black and white layers, containing alſo, probably, a few cryſtals of adularia and ſcales of mica. The ſtone I have now deſcribed appears to be of the ſame kind, and this is rendered more probable from its ſometimes containing felſpar.

BROWNISH-

Brownish-Black Pitchstone—*South Side of Glencloy.*

Colour. Browniſh-black.

Luſtre. Little glancing, with waxy luſtre.

Tranſparency. None.

Hardneſs. Gives a few ſparks with ſteel.

Fracture. Uneven, with a tendency to the conchoidal.

Fuſibility. At 21° it intumeſced a little; its colour was ſlightly altered; the ſurface glazed, and, internally, porous. At 31°, intumeſced conſiderably, and ſoftened. It had then, externally, a browniſh glazed covering; internally, colour is grey, and very porous. At 65° it had intumeſced very much; forming an externally cavernous, yellowiſh-brown coloured maſs. At 100° it became more compact.

There are generally a few cryſtals of white felſpar diſperſed through it; and it acquires, by the action of the weather, a ſlight brown tegmen.

Black Pitchstone.

Colour. Black.

Luſtre. Little glancing, with a waxy luſtre.

Tranſparency.

Tranfparency. None.

Hardnefs. Gives a few fparks with fteel.

Fracture. Straight, flaty; and the flates appear to be formed by the fuperpofition of fmall foliæ. The plates are alfo fometimes covered by a metallic yellow-coloured illinition.

Smell. When powdered, it emits a bituminous fmell; which renders it probable it may contain inflammable matter *.

It has generally a few cryftals of white felfpar difperfed, and thefe by decompofition acquire a brown colour: fometimes we alfo obferve a yellow-coloured, nearly tranfparent fubftance accompanying the felfpar.

Thefe different kinds of black pitchftone appear to pafs into bafalt. A curious fpecimen of this kind occurred to me in the neighbourhood of Kilmichael-Houfe, in Glencloy. One part is common black pitchftone, but it gradually lofes its luftre; its fracture paffes from the conchoidal to the plain fplintery; then it gives a grey ftreak, is not at all fragile, in fhort, is a fair bafalt.

OBSER-

* Mr. Kirwan has found feveral pitchftones to contain inflammable matter. *Kirwan's Mineralogy.*

OBSERVATIONS.

When pitchſtone was firſt diſcovered, it was believed by mineralogiſts to be the lapis obſidianus of Pliny *: its reſiny or pitchy colour, however, ſufficiently diſtinguiſhed it from the true obſidian, which was afterwards found in Hungary, Iceland, the South-Sea Iſlands †, &c. It was firſt diſcovered in Saxony; but it has not till now been deſcribed as a Britiſh foſſil.

From its great reſemblance to certain volcanic productions, it has occaſioned a conſiderable warfare between the Neptunian and volcanic philoſophers. The volcaniſts reſt their opinion on the following facts. 1. Pitchſtone has been obſerved to paſs into obſidian; a ſtone which is found in the neighbourhood of Mount Hecla in Iceland, and hence reckoned volcanic. 2. Pearlſtone, which ſeems only a ſpecies of pitchſtone, is

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* Baron Veltheim has endeavoured to ſhew that the obſidian of Pliny correſponds to ſeveral other ſtones.

† Newes Bergmanniſches Journal. B. i. § 94.—The whole of the Iſle of Aſcenſion, according to Foſter, is compoſed of obſidian.

found not only to inclofe balls of obfidian, but even to pafs, on the one hand, to obfidian, and, on the other, to real pumice *. Mr. Camara, who had examined the pitchftone of Hungary, was convinced, from its alternation with rocks decidedly Neptunian, that it could not claim a volcanic origin; and he rendered his proof more complete, when he demonftrated, that the obfidian was converted into a porous fpongy mafs by the blow-pipe, intimating that it had never been expofed to the action of volcanic fire †. More lately, Lampadius, profeffor of chemiftry at Freyberg, has found, that the pitchftone is affected by fire in the fame way as the obfidian ‡; and has completely overthrown the volcanifts, by the difcovery, that the true obfidian contains 2 lb. 5 oz. of water per cent. ||

As the pitchftone which occurs in Arran is convertible into a porous or fibrous mafs by the action of the fire, and forms veins

* Efmark N. Bergmannifches Journal. Vol. 2.

† Bermannifches Journal, 1794. B. 2. § 245.

‡ Neues Bergmannifches Journal. B. 1. § 84.

|| A whole pound weight of obfidian was diftilled in a porcelain retort, and afforded 145 grains of pure water.

veins in ſandſtone, a volcanic formation cannot be attributed to it.

Fuſibility of Pitchſtone. Pitchſtone has been found by mineralogiſts to poſſeſs ſo very different degrees of fuſibility, that it leads me to enquire if they have all employed the true pitchſtone in their experiments. Mr. Morveau Guyton found the pitchſtone of Menil mountain, near Paris, to remain unaffected at a very high degree of Wedgewood's ſcale *. Mr. Kirwan, who has made many experiments on their fuſibility, found that the moſt fuſible formed an enamel at 130° of Wedgewood; but in general were far more refractory, ſome remaining unchanged at 160° †. It is plain that theſe foſſils are quite diſtinct from the pitchſtone of Arran: indeed, were they proved to be the pitchſtone of Werner, I would not heſitate to arrange the Arran ſtones as a new and diſtinct genus. It is now known, however, that ſeveral ſtones, which formerly paſſed for pitchſtone, belong to the ſemiopal. Dr. Mitchell informs me that the infuſible pitchſtones of Hungary are ſemiopals; and Dolomieu remarks, that the pitchſtones of the iſland of

 Elbe,

* Journal Polytechnic.

† Elements of Mineralogy. Vol. 1. p. 293, 294.

Elbe, Piedmont, and the wood which is converted into yellow and white pitchſtone from Hungary, are all very difficultly fuſible, and he therefore reckons them reſiniform chalcedonies †, (or, more properly, ſemi and wood opal.) It is not then improbable that the pitchſtones, which Mr. Kirwan and Morveau Guyton examined, were ſemiopals, or ſtones nearly allied to it.

The real pitchſtone, according to Emmerling, is eaſily fuſible ‡; Dolomieu found the pitchſtones of the Iſles Ponces and of the Paduan mountains eaſily fuſible; and, laſtly, Meſſrs. Camara, Deriabin and Lampadius obſerved a ſimilar fuſibility. Theſe facts agree with my trials on the Arran pitchſtone, and entitle me to reckon it the pitchſtone of Werner.

BASALT.

Basaltes, Marmor. Agricol. *Borax Basaltes*, Lin. *Basaltes Columnaris*, Waller. *Argilla Basalte*, Werner. *Common Trap*, Kirwan.

Basalt—

† Journal de Phyſique. Vol. 40. p. 215.

‡ Lehrbuch der Mineralogie. B. 1. § 264.

BASALT—*South Side of Glencloy.*

Colour. Black.

Luſtre. A number of ſhining particles diſperſed through it, which is probably hornblende *.

Tranſparency. None.

Hardneſs. Scarcely gives fire with ſteel.

Fracture. Even earthy, but is very compact.

By decompoſition acquires a browniſh-coloured tegmen.

BASALT, *which forms a vein running in the porphyry—Head of Glencloy.*

Colour. Lavender blue, intermixed with yellowiſh green; by decompoſition, red.

Luſtre. None.

Tranſparency. None.

Hardneſs. Yields pretty eaſily to the knife.

Fracture.

* Hornblende having been found to contain charcoal, or probably carbone, as a conſtituent part, has been ingeniouſly mentioned by Dr. Walker, as one fact, to ſhew the tranſition from plumbago to hornblende, which he imagines he has obſerved in ſeveral other inſtances.

Fracture. Rather uneven fine ſplintery.

Fuſibility. Melted at 103°.

BASALT, *which forms veins traverſing the granite— Eaſt Side of Glenroſa.*

Colour. Greyiſh, or black.

Luſtre. A number of cryſtals of hornblende, diſperſed through it, give it a ſlight degree of luſtre.

Tranſparency. None.

Hardneſs. Gives a few ſparks with ſteel.

Fracture. Uneven earthy.

Gives a grey trace.

Fuſibility. Melted at 58°. This fuſibility diſtinguiſhes it from the ſpecies of baſalt examined by Mr. Kirwan. He found them fuſible from 120° to 130°; and the figurate trap, or columnar trap, melted at 100°.

It contains yellow-coloured olivin, and in greater quantity than I have obſerved in other ſpecies.

In the former edition of this work, I conjectured that both the pitchſtone and baſalt might contain potaſh. Since that period, Dr. Kennedy has analyſed baſalt, wacken-porphyry and greenſtone, and theſe he finds to contain a ſmall portion of

ſoda

ſoda and muriatic acid ‡. Dr. Mitchell, to whom I communicated Dr. Kennedy's experiments, has lately repeated them upon the famous baſalt of Stolpen, but obtained a very different reſult. Having detected a ſmall portion of muriatic acid, he then powdered a quantity of the ſtone, and mixed it with ſulphuric acid; then diſtilled to dryneſs, and lixiviated the ſolution: the ſolution was decompoſed by the acetite of lead; the ſupernatant liquor was then evaporated to dryneſs, and the acetous acid burned off. The reſidue, which was pure alkali, afforded, with nitrous acid, priſmatic nitre: a deciſive proof of potaſh.

SIENITE.

Sienites, Marmor. *Pyropoecilus*, Plin. et Al. *Syenites*, Dr. Walker's Claſſ. Foſſil. *Granites Sienites*, Gmelin. Syſt. Nat.

This rock we have remarked forming ſtrata at the head of Glencloy, and it occurs in many other parts of the iſland: I ſhall now mention its external characters. To prevent repetition, I will ſhortly detail the different ſpecies, placing the ingredients in their order of proportion.

1. Felſpar;

* Tranſactions of the Royal Society of Edinburgh, vol. 5th.

1. Felſpar; reddiſh.

Hornblende; green, and ſometimes black.

Quartz; white, and ſometimes brown.

This ſpecies is more or leſs compact, and is ſometimes ſhiſtoſe.

2. Hornblende; green.

Quartz.

Felſpar.

This aggregate, which is almoſt entirely compoſed of hornblende, has the following characters:—

Colour. Dark leek-gren.

Luſtre. A number of ſhining points diſperſed through the the maſs, owing to the hornblende.

Tranſparency. None.

Hardneſs. Gives fire with ſteel, but not very plentifully. —Leaves a grey trace. It is difficultly diſtinguiſhable from many ſpecies of baſalt, and is often intermixed with patches of the firſt ſpecies.

3. Quartz.

Felſpar.

Hornblende.

This ſpecies, owing to the great proportion of quartz, has much the appearance of a ſandſtone.

4. Horn-

4. Hornblende.

Quartz.

Felſpar; greeniſh-coloured.

The hornblende, in this compound, has ſometimes a metallic luſtre, approaching to the nature of ſchiller ſpar; and the felſpar is tinged green, owing to the diffuſed matter of the hornblende.

OBSERVATIONS.

The different ſpecies of ſienite were long confounded with baſaltic and granitic rocks: a circumſtance which was owing, not only to the want of an appropriate name, but to the difficulty of diſtinguiſhing the gradations. Werner firſt named it greenſtone; but he now calls it Sienite, from a conviction that it was a ſimilar ſtone which Pliny deſcribed as being found at Sienna in Upper Egypt. In antient times it was quarried in great quantities at Sienna; and from thence was brought to Rome for the building of great public edifices, and for the uſe of the ſtatuaries, who worked it into pyramids, obeliſks, &c. The famous Sarcophagus of Cheops, and Pompey's Pillar at Alexandria, are now known to be of ſienite.

As the diſcovery of metallic veins is one of the great objects of mineralogy, we think it not out of place to introduce, among the general obſervations we may have occaſion to make during the courſe of the work, a ſhort account of the different veins of ore which have been obſerved traverſing ſimilar rocks in other countries. In purſuance of this plan, we may remark, that ſienite, in ſome places, is rich in metals: thus, at Schauffenberg there are veins of ſilver and lead, and part of the productive Altenberg mine-works are in ſienite: we believe that the veins of Strontian in Argyleſhire run in a ſimilar rock.

CLAY PORPHYRY—*Cory-Gills.*

Thon Porphyry, German.

Colour. Browniſh baſis; by decompoſition, acquires a white tegmen.

Luſtre. None.

Tranſparency. None.

Hardneſs. Is difficultly ſcraped with a knife.

Fracture. Splintery.

Smell. Strong earthy ſmell, when breathed on.

Felspar

Felspar—Is of a browniſh colour; ſometimes white and cryſtallized.

Quartz—Is of various colours, white, yellow, or ſmoke; of different ſhapes, angular, rounded, or regularly cryſtallized, preſenting often ſix-ſided pyramids, which is a rare appearance in porphyry: it is alſo ſometimes diſperſed through the baſis in the form of ſtrings.

PORPHYRY—*Glencloy.*

The baſis of this porphyry differs, in general, but little from that of Corygills: in particular inſtances, however, we obſerve it nearly in the ſtate of hornſtone, and having the following characters:

Colour. Grey.
Luſtre. None.
Tranſparency. A very ſlight degree at the edges.
Hardneſs. Gives a few ſparks with ſteel.
Fracture. Even.
Smell. A ſtrong ſmell, when breathed on.

The cryſtals of felſpar are much larger than in the clay-porphyry; and, beſides, I obſerved it to contain a ſoftiſh ſubſtance, probably ſteatitical.

GENERAL OBSERVATIONS.

The true porphyry was long confined by mineralogiſts to a particular ſtone which was ſuppoſed to have a jaſpideous baſis; but Werner has extended its ſignification much farther, and now reckons eight different kinds. It would be uſeful here to follow the Linnæan mode, by dividing them into diſtinct genera; and then the ſpecies might be deſcribed in ſhort characters, as has been done in botany. This will probably be reckoned uſeleſs labour by thoſe who think that foſſils are not capable of ſuch arrangement: we are well convinced, however, that, in the preſent inſtance, as well as in many other parts of mineralogy, much good may be done by ſuch attempts.

In modern times, porphyry has been principally uſed for ornamental purpoſes; and, where compact, it has been found to anſwer well for millſtones. The Greeks and Romans uſed it for the conſtruction of their fineſt edifices; and the ſtatuary often cut it into buſts, vaſes, &c. of the moſt exquiſite workmanſhip.

The

The porphyry in this iſland, ſo far as my experience goes, does not afford any veins of ore; yet in other countries it is ſometimes productive. Thus, in different parts of Germany, a ſpecies, ſimilar to what we obſerve in this iſland, has been found to contain veins of tinſtone, iron ore, mangane.ſe, galena, and molybdæna.

SILICEOUS SHISTUS.

Gemeiner Kieselschiefer, Wern. *Hornflint.*

Among the debris which covers the bottom of Glencloy, I diſcovered ſpecimens of a rock which ſeems to be ſiliceous ſhiſtus; but I could not diſcover it *in ſitu*. It preſents the following characters:

Colour. Grey, or greyiſh black.
Luſtre. None.
Tranſparency. Tranſmits extremely little light at the edges.
Hardneſs. Gives fire plentifully with ſteel.
Fracture. In the groſs, ſlaty; of the ſingle plates, more or leſs fine ſplintery, inclining to the even.

It has diſperſed through it grains of quartz, and very minute

nute particles of a fofter fubftance, whofe nature I could not determine.

GRANITE.

Granites genuinus, Lin. *Granites durus*, Cronfted. *Saxum quartzo*, *fpato fcintillante et mica in diverfa proportione mixtis*, *compofitum;* Waller, Syft. Miner. vol. i. p. 407.

The granite of this ifland is, in general, pretty compact; of a whitifh-brown colour, owing to the flight-brown tinge of the felfpar. To defcribe all the varieties that occur might be ufeful; but that is more adapted for a fyftematic treatife of mineralogy than an outline of this kind. I fhall only, therefore, give a particular account of two fpecies; the Great-grained, or Common Species, and the Small-grained.

I. Great-grained Granite.

This fpecies is not only remarkable by its forming a very confiderable part of the folid materials of the ifland, but alfo on account of the peculiarity of its compofition; as it frequently contains three fpecies of felfpar, and the quartz is often cryftallized.

1st Species, FELSPAR—Is of a white colour, with a ſlight tendency to the brown; having the uſual luſtre, tranſparency, and hardneſs.

2d Species, *ADULARIA?*

Colour. White.

Form. Either in amorphous maſſes, or cryſtallized in hexahædral priſms, bevelled at both ends.

Luſtre. External, like that of cryſtals not much poliſhed; internal, ſame.

Tranſparency. Sometimes objects can be ſeen pretty diſtinctly through the cryſtals; but when they are a little decompoſed, opacity is produced.

Fracture. Plain foliated, and ſometimes ſtriated.

Hardneſs. Gives fire plentifully with ſteel.

Fuſibility. At 100° the ſurface was formed into a yellow-coloured enamel.

3d Species—Is of a white colour, having nearly the uſual hardneſs, fracture, &c. of the common felſpar; differing principally in the luſtre, which is like that of poliſhed metals, reflecting, in certain directions, a ſilver light.

QUARTZ—

Quartz—Is frequently colourlefs; alfo greyifh, pale yellow, pale, or dark brown, and fometimes nearly black, when it is called Morion.

Is very often cryftallized; and either in the form of hexangular prifms, terminated by hexangular pyramids at one or both ends, and the prifms are feamed acrofs. The cryftals are fometimes found feveral inches long, and from two to three inches diameter; of a pale brown, or rather fmoke colour. Thefe laft are much valued by the lapidaries.

Mica—Is often black; fometimes golden yellow, tombac brown, or green. It is generally in the form of irregular plates; and pretty frequently hexagonal plates occur, which, being fuperimpofed upon each other, form a hexagonal figure of fome magnitude. It is the mica lamelleuse hexagone of Rome d'Ifle, (vol. ii. p. 509.) and the hexagonal mica of the Abbé Huay, (Miner. vol. v. p. 296.)

The conftituent parts of the granite are very various in their proportion; but, in general, the felfpar forms the moft confiderable part, then the quartz, and laftly the mica.

II. Small-

II. Small-Grained Granite

Is very compact, with an uneven fracture; compofed of felfpar and quartz, in nearly equal proportions, with very few fcales of black mica. It is fubject to much variety; not only on account of the fize of the particles, but alfo from their relative proportion, their degree of compactnefs, &c. Some varieties are fo compact, and have fuch a general appearance, as eafily to pafs for fandftone: but a careful examination of the figure of the particles, the want of fubftramen or bafis, and, laftly, its fituation in the earth, afford fufficiently diftinct marks of difference. It is generally found in fiffures, which traverfe the great-grained granite in all directions; but it alfo occurs in patches difperfed through it *.

BRECCIA.

I have already remarked that the common breccia, which runs among the fandftone, is formed of fragments of fand-

* It has been obferved in the mountains of the Hartz, that granite affects the magnetic needle; but it is faid only in mafs, and in a perpendicular vein. Mr. Deriabin, however, informs me, that this is not quite correct; for he has obferved it to act in detached pieces.

ſtone and quartz, immerſed in an arenaceous baſis. Another ſpecies occurs upon the ſummit of the ſienite hills, back from Glencloy. It has an arenaceous baſis, approaching, in appearance, to baſalt; and containing rounded or angular maſſes of granite ſimilar to that which forms Goatfield, micaceous ſhiſtus, quartz, porphyry like that of Glencloy, baſalt, and paliopetre. I was not able to diſcover its real ſituation; but its compoſition ſhewed that it was probably interpoſed between the primary and ſecondary ſtrata. The circumſtance of its containing granite, explained a phenomenon which long puzzled me—the appearance of rounded maſſes of granite upon the ſummit of ſeveral high hills; theſe evidently owing their origin to the decompoſing breccia.

A R R A N.

CHAP. V.

Cory; Cock of Arran; and Loch-Ranza.

HAVING now given a pretty extended defcription of the ftrata and foffils in the neighbourhood of Brodick Bay; I fhall, in the next place, proceed to trace the ftrata round to Loch-Ranza, which is fituated upon the north-weft fide of the ifland.

From Brodick Bay, the cliffs all around are low, and, for a great way, compofed of the ufual red fandftone, which is much traverfed by veins of bafalt, of various widths, and running in different directions. Coves occur in feveral places, but none are of confiderable fize: frequently calcareous ftalactites hang from their roofs. The action of the fea upon the fandftone has given a fingular afpect to the whole fhore; owing

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to foft fandftone being wafhed away, while the more compact and hard, which appears to have been formed in fiffures, is left ftanding in long ridges, or criftæ. The fandftone, as it rifes upwards, forms part of the lower region of Goatfield, in the vicinity of the micaceous fhiftus, which it, in all probability, covers. About a mile from the Cory, nearly one hundred feet above the level of the fea, there is a ftratum of limeftone, about twelve feet thick, running at an angle of 20°, and covered with red-coloured argillaceous fandftone; but, below, interpofed between the limeftone and fandftone, there is a layer of a red fhiftofe clay. In this clay I obferved regular feries of fhells, depofited in layers, (all appearing of the fame fpecies,) with their convex fides regularly downwards. The ftratum is fometimes ftraight, but often waved and twifted. It alfo frequently contains radiated calcareous cryftals, which are of a reddifh colour, owing to the admixture of iron. In a fiffure of the fandftone, above the limeftone, I obferved ftalactites of peat, of confiderable fize and confiftence, which appear to have been formed by the infiltration of the foluble peat-matter through the fandftone. To the N. of this ftratum there is a confiderable ravine, which luckily afforded me an opportunity of obferving the junction of the different ftrata. Here I traced the common red-coloured argillaceous fandftone from the fhore to a confiderable height, and, in fome places, obferved

ſerved it intermixed with fragments of quartz; thus forming a kind of breccia. As we approach the primitive rocks, the ſandſtone ſtrata become more elevated; and, at length, I obſerved it lying on a compact ſhiſtoſe rock, which appeared to be of the nature of micaceous ſhiſtus; but it was ſo much decompoſed by the action of the weather, that I could not well determine exactly as to its particular deſignation. This micaceous ſhiſtus? continues but for a ſhort way, when it is to be ſeen lying on the granite, which riſes upwards, forming a very ſteep aſcent, which leads to the rugged and ſterile-looking Coryglen. This glen is very precipitous on all ſides; is broader than any in the Goatfield groupe, but is comparatively ſhorter: its bottom is higher than that of Glenroſa, but not ſo much elevated as that of the Cory-dain or Feun-hody. It is entirely compoſed of granite; which is here ſplit, as uſual, into immenſe blocks, that are piled in vaſt tumuli upon the tops of the ſurrounding mountains, or cover the ſides and bottom of the glen, as with ruin and deſolation.

Having returned again to the ſea-ſhore, I continued my journey; and, as I approached the Cory, obſerved a vein of ſoft, red, ſhiſtoſe ſandſtone, containing rounded pieces of argil running through the ſandſtone N. E. and S. W. At the Cory, where there are a few houſes, I obſerved quarries of

ſandſtone,

ſandſtone, of a beautiful white colour, and of good conſiſtence for building. Theſe quarries are now worked, by a company, for the conſtruction of the Crinan Canal. Here there is alſo a ſtratum of limeſtone, about thirty feet thick, conſiderably inclined to the horizon, running N. N. W. and divided into ſtratulæ, as the ſtratum formerly mentioned, with intervening clay and ſhells, but the clay is more or leſs indurated. From this towards Weſt Sanicks, the ſhore is compoſed of the common red-coloured ſandſtone, interſected here and there with veins of baſalt; but it is often ſo covered with bowlder ſtones of different kinds, as to render travelling very difficult. The rounded maſſes of granite, ſcattered up and down here, are of a moſt aſtoniſhing ſize; ſome of them hundreds of tons weight. Near to the Sanicks, there is an immenſe ſtratum of breccia, which is compoſed of rounded fragments of quartz, and micaceous ſhiſtus, cemented by an arenaceous ground. The breccia is in many places much broken. Immenſe maſſes of it, many hundred tons weight, lying ſeparated from the ſtratum only a few feet, render it probable, that theſe maſſes were diſunited by froſt. In one place, I obſerved, a conſiderable ſection of the breccia, which I examined very carefully, in order to diſcover if the maſſes of quartz, were compreſſed and ſmaller at the lower than the upper part, but no difference could be obſerved. Very remarkable inſtances of this kind have been ob-

ſerved

ferved in other countries; thus in Bergm. Erde-Befch. 182, we are told that in the mountains of Quedilia and Portfiællet in Norway, which confift of an argillaceous puddingftone, the filiceous pebbles it contains, are obferved to be compreffed to the thicknefs of the fourth of an inch, in the lower parts of the mountains, but to increafe in fize and roundnefs in proportion as their fituation is higher. Alfo in the Vivarois, the loweft ftrata of primitive limeftone, have been found of the thicknefs of one-tenth of an inch; but in proportion to their elevation in the mountain their thicknefs increafes, until at its fummit, it arrives at thirty or forty feet. 1. Soulavie, 178. Ferber made the fame obfervation in England.

At a little diftance from the fhore, is the entrance into the deep South Glen-Sanicks, which is about four miles long, running nearly E. and W., and bounded on both fides by lofty mountains. As I obferved a confiderable ftream of water running through this glen, I determined to examine it, as it was probable that the ftrata would be well expofed. Having walked for upwards of a mile in the direction of the glen, I defcended into the ravine formed by the water, but found ftill the ufual red-coloured argillaceous fandftone. As we continued clambring upwards, I obferved feveral veins of fulphat of barytes, fome nearly four feet wide, traverfing the fand-

ftone;

ftone; and, by a little care, I obtained fpecimens pretty well cryftallized. About a quarter of a mile further on, a very compact arenaceous breccia (principally compofed of rounded pieces of quartz, and a fpecies of bafalt, which has, interpofed, grains of felfpar, and a yellow fubftance,) makes its appearance; and this extends to a confiderable diftance; but it is at length apparently interrupted by a ftratum of hornblende rock. This ftratum of hornblende rock is only a few feet wide; and it appears to lie immediately on the granite. I have to regret that I could not obtain more fatisfactory views of the junction of thefe ftrata, owing to the great covering of debris. I am fomewhat confident, however, that the difpofition of the ftrata is pretty nearly as now ftated, viz. that in the lower parts, and for a confiderable way upwards, is argillaceous fandftone; next, arenaceous breccia; then a bed of hornblende rock; and, laftly, granite.—The glen is now bounded by lofty granite mountains: on the N. is the Caimes, with part of Caime-na-caillich; and, towards the S., Keich-na-hien and Goatfield form boundaries awfully grand. Its fides are much furrowed by the action of the rain: which circumftance, with the red colour of the decompofing granite, the immenfe granitic blocks which cover the fides and tops of the mountains, form altogether a fteril and tremendous fcene.

In

——— In lonely regions, here, retired
From little ſcenes of Art, great Nature dwells
In awful ſolitude.

Here I obſerved ſeveral veins of baſalt traverſing the granite; and, in ſome places, I could trace the perpendicular veins from the top to the bottom of the mountains. At the top of this glen is the hollow called Cory-na-huave, which is bounded by Caime-na-callich and Keid-voe. Its bottom is higher than that of Glen-Sanicks; and is entirely compoſed of granite, traverſed with veins of baſalt, ſome of which have a conſiderable degree of curvature.

Having examined this glen as far as my time would permit, I was again proceeding toward the ſea-ſhore, when I thought it might be intereſting to examine the junction of the granite and ſhiſtus in ſome of the neighbouring glens. I therefore changed my courſe, as ſoon as we came to the rock of breccia which I have juſt deſcribed; and from this I croſſed over a hill of ſimilar rock to North Glen-Sanicks. Here we obſerved a ſtream running through the glen, and in it I found the ſhiſtus in immediate contact with the granite. The ſhiſtus appeared to be a very compact micaceous rock; but the granite was not intermixed with it at the junction, nor were there any veins

to be obferved fhooting from the granite into the micaceous rock. We now croffed over the hills into another glen, where I obferved another junction of the granite and fhiftus, but it prefented nothing remarkable.

I now returned again to the fhore, below the entrance of South Glen-Sanicks; fo that I might proceed regularly on my tour through the ifland. After paffing the Sanicks burn, I found the fandftone, breccia and bafaltic veins ftill continuing; but the appearance of the mountains was much changed. The peaked fummits, and almoft perpendicular, furrowed fides, now difappeared: the mountains were cloathed with heather to their fummits, which were more or lefs round-backed: intimating an alteration in the materials of which they are compofed; which is really the cafe, as the granite had now difappeared, the fummits of the largeft hills being of micaceous fhiftus, which, in fome places, alternated with talcaceous fhiftus. I now wandered along a mile or two of fhore compofed of fandftone; when my attention was arrefted by the remains of workings for coal, at a little diftance from the fea-mark the Cock of Arran. This coal ftratum, which is but of fmall extent, runs in the fandftone, accompanied by the ufual coal metals, as, argillaceous ironftone, fhiftofe clay containing numerous vegetable impreffions, &c., and at the bottom of a mountain

mountain of micaceous ſhiſtus. It is ſimilar to that which is found at Kilkenny in Ireland, and is called blind-coal *. I obſerved two pits, about fifteen feet deep, which had been dug in cutting the coal ſtratum; but, as the coal ſoon diſappeared, the pits were left, and the ſalt-pans which had been erected were rendered uſeleſs. The ſituation of this ſtratum is ſuch, as to preclude all hopes of finding any conſiderable quantity of coal, although freſh ſections were made: for we invavariably find it to be the caſe, that wherever coal ſtrata come into the vicinity of high mountains, they then moſt certainly decreaſe in breadth, and become bad, owing to the great admixture of earthy matter. Thus, many of the ſeams of coal which have been found in France are trifling, and continue but for a ſhort way; owing to their ſituation, being found in vallies that are bounded by granite, or other primary rocks †.

* Dr. Hutton conceives that this ſpecies of coal preſents an irrefragable proof of the truth of his theory. Here, ſays he, is a coal having all the properties of that which has been ſubmitted to the action of heat; the bitumen is ſeparated, and charcoal remains. To the Neptuniſts, this affords one of the ſtrongeſt arguments againſt the theory. The ſeparation of bituminous matter ſhows a want of immenſe compreſſion, which is the grand fundamental baſis of the hypotheſis. It is indeed this circumſtance, principally, which diſtinguiſhes it from the volcanic theory, and has led Mr. Kirwan to name it the Plutonic.

† Journal des Mines.

The great frequency of bafaltic veins is another caufe which may render the coal, if it fhould again be deemed worthy of attention, of an indifferent quality, and difficult to work.

From this ftratum to the Cock, which is the moft northern point of the ifland, the fhore is covered with immenfe maffes of fandftone and breccia, which have tumbled from the neighbouring hills by the action of the weather. Ironftone is found fcattered upon the fhore, and is probably connected with the coal workings. The Cock is not, as I expected, a headland, but merely an enormous mafs of fandftone, lying loofe upon the fhore, having a fancied refemblance to the head of the cock. Here the cliffs are of confiderable height, compofed of fandftone and breccia, traverfed with veins of bafalt of various fizes. One of thefe veins is compofed of a reddifh brown-coloured bafalt, with, interfperfed, white-coloured, apparently cryftallized fpecftein of Werner; and the bafalt, where it is in contact with the fandftone, is hard, and much refembles hornftone. After leaving this, a ftriking appearance prefents itfelf to our view, of the whole face of an immenfe ftratum of breccia, which was fhattered to pieces, and rolled towards the fea, by an intenfe froft fome years ago: the crafh of its fall was heard far off. The fandftone upon this part of the coaft is alternated with layers of fhistofe clay; and where the clay is wafhed

away

away, the ſandstone lies expoſed, having the appearance of a regular pavement. If we examine it more nearly, we find the ſandstone strata ſplit into two, four, or ſix-ſided irregular figures, and connected together by the clay, which gives it an artificial aſpect; by the decompoſition of the clay, the pieces of ſandstone are ſeparated, and lie ſcattered on the ſhore, and are apt to be taken for the work of art. From this to within a mile of Loch Ranza, the ſandstone, as uſual, forms the cliffs upon the ſhore, and is backed by mountains of micaceous ſhistus, upon which it rests. Here, however, the ſandstone diſappears, and the micaceous ſhistus now forms the cliffs, which become higher as we approach Ranza. At the place where the ſandstone diſappears, there is a great baſalt vein, about thirty feet wide, running in a rock intermediate between ardeſia and micaceous ſhistus. As we approach nearer to Loch Ranza, the ſea has expoſed ſeveral other ſimilar appearances, but far more distinct than the first. Theſe veins are of various ſizes; ſome are curved in their direction; one, in particular, is forked, or divided into two branches, which run in very different directions through the micaceous ſhistus. A few hundred yards from the entrance of the Loch, the ſea has formed an intereſting ſection of the ſtrata, which demonſtrates, in a ſatisfactory manner, the relative poſition of the ſandſtone, limeſtone, and mi-

caceous

caceous ſhiſtus. The micaceous ſhiſtus which forms the ſhore, is inclined at an angle of 45° and dips to the S. E.; the ſecondary ſtrata, are inclined at an angle of 45°, but dip to the N. W. ſo that the two kinds of ſtrata meet together, ſimilar, as Hutton remarks, to the two ſides of a lambda, or the roof of a houſe. The ſecondary ſtrata are of red coloured argillaceous ſandſtone, (which ſometimes appears paſſing into breccia:) which alternates with limeſtone. This limeſtone ſometimes contains maſſes of hornſtone, a fact, ſomewhat ſimilar to the occurrence of flint in the chalk beds of England. Sauſſure remarks that hornſtone is confined to the ſecondary limeſtone, quartz being the ſporadic matter which he has obſerved in primitive limeſtone. Many other veins may be obſerved traverſing the micaceous ſhiſtus, before we arrive at the entrance of Loch Ranza, but any detailed account of theſe would be but a repetition of what has been already mentioned.

Glen-Ranza. This glen is about two miles long, and half a mile broad, running nearly north and ſouth, bounded on both ſides by lofty round-backed mountains, that riſe at a very conſiderable angle, and are nearly of the ſame height on both ſides of the glen. The inclination of the oppoſite mountains is the ſame, and the ſtrata run at the ſame angle. The

JUNCTION OF THE PRIMARY & SECONDARY STRATA NEAR LOCH RANSA

A A *Sand-Stone* B B *Lime Stone Strata* C *Micaceous Shistus*
D *Basaltic Vein*

R. Scott sculp.

EAST SIDE of GLEN ROSA

The bottom of the glen is but little elevated, and nearly level; about one half is covered with a falt water loch, which adds greatly to the beauty of this romantic fpot. The hills are compofed of micaceous fhiftus, containing a greater or leffer proportion of quartz and mica; indurated chlorite is alfo difperfed through it, and towards the mouth of the loch there is a confiderable ftratum of ardefia, or primitive argillaceous fhiftus, bounded by the ftrata of micaceous fhiftus.

Glen-es-na-birach. From the top of Glen-Ranza, we enter, by a narrow paffage, into a long deep glen, running nearly in the fame direction, called Glen-es-na-birach, bounded on both fides, with mountains of compact micaceous fhiftus, which lie upon the granite. The granite and fhiftus are often intermixed at their junction, and fometimes fmall granite veins are to be obferved iffuing from the maffive granite, and traverfing the fhiftus. This latter appearance was confidered by Dr Hutton, as a demonftration of the truth of his theory, with regard to the formation of granite. I will not now make any obfervations on this particular opinion, as I intend to confider it fomewhat fully in a fubfequent part of the work. As we advance further up the glen, the micaceous fhiftus difappears, when both fides are formed of granite, of the fame kind with that of Goatfield. The bottom is alfo formed of granite, as is well

demonftrated

demonftrated by the ftream, or burn, which has laid bare the rocks through the whole extent of the glen; it is indeed by rivulets of this kind that we are often enabled to have a diftinct view of the mineral ftructure of highland countries. From the further extremity of this glen, is the afcent to Caimena-caillich, which is in feveral places rugged and difficult, from the number of loofe blocks of granite fpreading all around. Upon afcending, we firft ftop at the edge of what is called the Garife-hodie: Here a wonderful and moft tremendous fcene prefents itfelf to our view. An immenfe hollow, many hundred feet deep, dreadfully rugged and broken, almoft entirely furrounded with mountains, whofe ferrated fummits are covered with immenfe tumuli of granite, exhibits to us, in very legible characters, the vaft operations of nature, in the formation and decompofition of our globe. What man, poffeffed of reafon, contemplating this awful fcene, could doubt of the exiftence of that BEING, whofe power and wifdom are far beyond the reach of human comprehenfion? If fuch a man exift, vanity, not foundnefs of judgment, is the diftinguifhing feature of his character. Few, indeed, of thofe who deny, or even doubt the exiftence of Deity, have ever beheld, far lefs ftudied, the ftupendous and awful works of nature. It is not, then, much to be wondered at, that the pride and arrogance, which fo often characterife the clofet philofopher, fhould find their

their way to mix with their daring and impious ſpeculations; which have for their end the propagation of the worſt principles, the diſſolving of all the bonds, and deſtroying the ſweeteſt endearments of human ſociety.

Upon the edge of the hollow, I obſerved ſeveral fragments of porphyry, but I could not diſcover any fixed rocks of it, owing to the blocks of granite ſcattered all over the ſides of the mountains. In aſcending from this, to Caime-na-callich, ſeveral other appearances of porphyry, and alſo fragments of baſalt and pitchſtone, preſented themſelves. After conſiderable fatigue I was ſo fortunate as to diſcover two veins of baſalt, upon the ſide of Caime-na-caillich looking into the Gariſehodie; and, between theſe, there appeared a perpendicular vein of pitchſtone, all running in the common granite. This pitchſtone, is of a green colour, much reſembling that from Brodick wood. It forms a vein, about two feet wide, and, what is remarkable, it is formed into two regular columns, from two to twelve inches diameter, and having from three to ſix irregular ſides *. I could not, however, diſcover the ſituation of

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* It would be worthy the attention of future travellers to determine whether the baſalt be not included in the ſame vein with the pitchſtone, thus forming a ſtratified vein.

the porphyry, although it was ſcattered in ſome places of the mountains in conſiderable quantities. Having gained the ſummit of this great mountain, which is nearly of an equal height with Goatfield, I had a very grand view; yet not ſo extenſive as that from Goatfield.

Its ſummit has a moſt ſingular appearance, owing to its being covered with enormous piles of quadrangular maſſes of granite, which reſt upon each other in a moſt fantaſtic manner, and have much the appearance of artificial tumuli. Such appearances are by no means peculiar to Caime-nacallich, for I have already remarked them upon the top of ſeveral of the granite mountains in the iſland. Here we can trace the granite in its various ſtages of decompoſition, from the ſolid rock to the looſe ſand; in its beginning diſintegration it ſplits into maſſes, having a greater or leſſer tendency to the quadrangular form; but theſe maſſes have ſtill a degree of connection amongſt themſelves, as is the caſe upon the mountain top. The next ſtep is the enlargement of the fiſſures, by which the maſſes are looſened from their connection, and tumble down from their elevated ſituations, upon the ſummits of the neighbouring mountains, or are hurried with impetuous velocity down the mountain ſide, covering the bottom of the glens with theſe ſtupendous ruins. Laſtly

Laſtly, theſe detached maſſes, by the action of the weather, are completely diſintegrated, forming a looſe ſand, which is left upon the tops or ſides of the mountains, or is carried in great quantities to the ſea ſhore by the torrents *. Sauſſure, at ſec-

* Dr Hutton remarks, that the ſtony matter of this globe has been formed by the decay of a former world, whoſe debris has been collected by various means, at the bottom of a former ocean. This part of the Huttonian theory differs but little from that of Count Buffon, yet it is ſo material for the general ſupport of the whole, that if it ſhall be diſproved, the ſolidity of the theory in general will be much impaired. If we examine a few of the numerous facts on this ſubject, we ſhall find no proof of the debris being carried to the fathomleſs depths of the ocean ; on the contrary, we will obſerve it diſpoſed of in a very different way. Thus in ſome caſes, the looſe materials waſhed from the mountains, are obſerved filling up great hollows ; and in other inſtances, rivers depoſit their earthy matters, and form extenſive plains, and not unoften the debris having reached the ſea ſhore, is thrown back upon the ſame or other ſhores. The following facts are in proof of theſe remarks. The plains of Crau and Camarque, in lower Languedoc, were formed by depoſitions from the Rhone, and the plains of Lombardy from that of the river Po ; the lands of Holland and the Delta of Egypt, ſeem alſo to be depoſitions of the debris, brought to the ſea ſhore by great rivers. In Egypt, the gathering of debris is very great, as is well authenticated by hiſtoric evidence : thus, we are told, that the town of Damietta, in lower Egypt, about the year 1243, was upon the ſea ſhore, but is now about twelve miles from it : and the town of Foc-ah which, three hundred years ago, was ſituated at the mouth of the Nile, is now ſeven miles diſtant. The country about the Baltic is alſo gradu-

tion 604 of his Voyages dans les Alpes, remarks, that granite is difpofed in ftrata, but that they are not always to be diftinguifhed, particularly in the granite of low countries and plains. This he conceives to be owing to the granite of low hills containing a great quantity of pierre de corne. This

ally incroaching upon the fea. Linnæus remarks that the fea ports of eaft and weft Bothnia are every year decreafing, and becoming incapable of admitting veffels; the inhabitants of the ports are obliged to change their feats, and fometimes remove a quarter of a mile nearer the fea. On the eaftern fide of Gothland, near Hoburg, the increafe of the continent for thefe laft ninety years, is about two or three toifes annually. The inhabitants of weft Gothland remark that the fea decreafes every ten years four or five lines perpendicularly, which, amounts, to forty or fifty lines in a century. According to this calculation, 600 years ago the fea was 25 inches deeper than it is at prefent. In Arran we have alfo a ftriking proof of the formation of land by the accumulation of debris. Innumerable other inftances might be mentioned. But we will not cite more, but conclude this note with the following ingenious obfervations from Mr Kirwan's Geological Effays. "Mariners were accuftomed, fays he, for fome centuries back, to difcover their fituation by the kind of earth or fand brought up by their founding plummets; a method which would prove fallacious, if the furface of the bottom did not continue invariably the fame. Fortis in his Travels through Dalmatia, p. 285, relates that urns thrown into the Adriatic upwards of 1400 years, fo far from being covered by mud, were found in the fame fituation, as they could have been fuppofed to have been the firft day of their fall; therefore, notwithftanding many particles of earth are, by rivers, conducted to the fea, yet none are conveyed to any

This pierre de corne, he continues, contains a great proportion of argillaceous earth; and as moſt ſtones, which have this earth as a conſtituent part, and in conſiderable proportion, ſplit into rhomboidal maſſes, ſo he concludes that it is the earth of the pierre de corne which is the cauſe of the ſplitting of granite, thus forming the numerous maſſes which prevent us from obſerving the ſtrata. This explanation, however ingenious, does not hold true with regard to the granite of this iſland: no argillaceous ſtone of that kind enters into its compoſition, yet ſtill it ſplits into very numerous rhomboidal maſſes.

Glen-Halimidel. Upon the eaſt ſide of Glen-Ranza there is an opening leading to a glen, named Halimidel, which is about

any diſtance, but are either depoſited at their mouths, or rejected by currents or by tides; and the reaſon is, becauſe the tide of flood, is always more impetuous and forcible than the tide of ebb, the advancing waves being preſſed forwards by the countleſs number behind them; whereas the retreating are preſſed backward by a far ſmaller number, as muſt be evident to an attentive ſpectator; and hence it is, that all floating things caſt into the ſea, are at laſt thrown on ſhore, and not conveyed into the mid regions of the ſea, as they ſhould be, if the reciprocal undulations of the tides were equally powerful." Kirwan's Geological Eſſays, p. 440, 441.

about two miles long, running W. N. W. and E. S. E. but which ſoon changes its direction, running nearly in a line with Es-na-birach. It is narrow at the bottom, but widens upwards, owing to the inclination of the ſides, which form an angle of about 60°; and the bottom alſo riſes, forming a conſiderable angle with the ſides. It is compoſed of various ſpecies of micaceous ſhiſtus and quartz. In ſeveral places baſalt veins may be obſerved traverſing the micaceous ſhiſtus, many hundred feet above the level of the ſea: even in the bottom of the glen, where the burn has expoſed the micaceous ſhiſtus, we obſerve baſalt veins croſſing it. Upon the eaſt ſide of the glen, ſeveral hundred feet above the level of the ſea, there are two quarries, which were formerly worked for ardeſia, but are now diſcontinued. The ardeſia is of various colours; generally bluiſh or green, and is intermixed with white quartz; the fiſſures often contain cryſtals of actynolite, and a ſpecies of quartz penetrated with actynolite, forming a ſtone ſomewhat reſembling praſe.

ARRAN.

CHAP. VI.

Deſcription of the FOSSILS *mentioned in the preceding Chapter.*

LIMESTONE—*Cory.*

Colour. Grey.

Luſtre. A very faint degree of luſtre.

Tranſparency. None.

Hardneſs. Scrapes with a knife.

Smell. Emits a ſtrong earthy ſmell.

Fracture. Even, fine, ſplintery, and very compact.

Fuſibility. At 140° Wedgewood, no appearance of fuſion.

Another ſpecies is alſo found at the Cory; of a dark-brown colour, minutely foliated, difficultly ſcraped with a knife, and wanting tranſparency.

LIME-

LIMESTONE—*near the Cock.*

Colour. Brick red.

Luſtre. A ſlight degree of luſtre from ſome diſperſed foliæ.

Tranſparency. None.

Hardneſs. Pretty difficultly ſcraped with a knife.

Fracture. Generally foliated, paſſing to the compact earthy.

INDURATED LITHOMARGA?—*found looſe on the ſhore between Brodick Bay and the Cory.*

Colour. Light blood-red.

Luſtre. None.

Tranſparency. None.

Hardneſs. Yields to the knife with conſiderable difficulty; gives a pink ſtreak.

Fracture. Even, bordering upon fine ſplintery.—Does not ſtain the finger; feels dry; does not acquire a poliſh by friction; after immerſion in water for two days, no appearance of diſintegration.

BASALT

BASALT—*from a vein near the Sanicks.*

Colour. Greyiſh green.

Luſtre. None.

Tranſparency. None.

Fragments. Uneven earthy.

Hardneſs. Pretty eaſily ſcraped with the knife.

Fuſibility. Melted at 58°.

BLIND-COAL.

Kohlenblende, German. *Native Mineral Carbon*, Kirwan.

Colour. Black; when freſh broken, reflects a golden yellow, or violet colour.

Luſtre. That of metals not much poliſhed.

Hardneſs. Yields rather with difficulty to the knife.

Fracture. Plain foliated.

Is not coated with illinitions, as that from Kilkenny in Ireland. It does not ſtain the fingers.

Hardly burns until wholly ignited, when it conſumes ſlow-

 ly,

ly, with a light, lambent, blue flame, which continues for a short time. According to Mr. Kirwan's method, it contains, in the 100 parts, 93 of carbon and 7 of ashes.

Mr. Kirwan, in the second volume of his Mineralogy, remarks, that coals are not soluble in acids. I have observed, however, that the coal of Arran is rendered soluble in water, by means of the nitrous acid, the carbonaceous basis appearing to be converted into an oxyd.

This substance has been placed in various parts of the mineral system, as with black-lead, molybdæna, manganese, &c.; but the late correct analyses that have been made, show it is carbon nearly in a pure state. Mr. Kirwan, upon consideration of its great purity, places it at the head of the coals, with the name of Native Mineral Carbon.

ARDESIA.

Argillite, Kirwan. *Primitive Argillaceous Shistus.* *Dachschiefer*, Emmerling. *Ardesia Tegularis*, Linn.

Colour. Greyish blue, or greyish green; sometimes both colours are intermixed in the same specimen.

Lustre.

Lustre. Silky.
Transparency. None.
Fracture. Streight, flaty.
Fragments. Tabular.
Hardness. Yields pretty easily to the knife.
Streak. Grey.

Does not adhere to the tongue; feels rather greasy, particularly the green-coloured; does not stain the fingers. There are often contained in the fissures, crystals of glassy actynolite.

MICACEOUS SHISTUS.

Lepidotes, Dr. Walker. *Shistose Mica*, Kirwan. *Glimmer Schiefer*, Werner. *Gneissum Micaceum*, Gmelin.

The few observations I have to make on this genus of rock should, in strict order, have been introduced in chapter second; but I wished previously to examine a greater number of specimens, so as to be better able to give a general idea of the whole.

It would be inconsistent with the brevity of this outline to

defcribe all the fpecies of this rock: I fhall therefore only mention it in general.

Mica. The mica, in general, is of a grey, or black colour; the fcales very fmall, and indeed often hardly diftinguifhable.

Quartz Is of a white colour; is fometimes difpofed in layers; and, in fome fpecimens, has a granulated appearance.

Talkerde, Werner; *Talcite*, Mr. Kirwan; *Lepis*, Dr. Walker. This fubftance occurs very frequently, indeed more fo than the mica; yet, as I am not well acquainted with the names given to its admixture with other foffils, I ftill retain the term Mica for the whole, in fpeaking in general.

Thefe three fubftances are often conjoined, forming a fpecies of flate; in other examples we obferve only quartz and mica conjoined, or quartz and talcite; and, laftly, felfpar, indurated chlorite and hornblende add to its variety. In general, the rock which thefe fubftances make is very compact; and often they are fo intimately combined, that it is difficult to determine whether it be mica, talcite or chlorite that is intermixed with the quartz. Frequently we fee the

the quartz a-wanting, when the mica paſſes to the ſtate of ardeſia.

Use, *&c.* Several kinds of this rock, particularly the quartzy, have been uſed for the building of ovens and furnaces, on account of their great infuſibility. No rock is more favourable for metallic veins; indeed, many of the richeſt mining countries are formed of it: we may inſtance the vaſt mines of Sweden, which are almoſt entirely ſituated in micaceous ſhiſtus.

ARRAN.

A R R A N.

CHAP. VII.

Glen-Catacol, Glen-Erſay, Glen-Clachan, Shiſkin, Tory-Lin, Benin-Head, Whiting Bay, Lamlaſh Bay, Lamlaſh Iſland.

HAVING glanced over the glens and ſtrata in the neighbourhood of Loch-Ranza, I will now proceed around the iſland by Glen-Catacol, which is about a mile and a half from Ranza. The ſhores in this direction are bounded by cliffs, which are neither very high nor rugged, but beautifully adorned with low ſhrubs, giving a richneſs of appearance ſeldom obſerved upon the ſhores of this iſland. The cliffs and mountains in the vicinity are formed of micaceous ſhiſtus, of various degrees of hardneſs, owing to its being more or leſs intermixed with quartz. They are ſeparated from the ſea by low beaches, of conſiderable extent, which, in ſome places, are cultivated. The entrance to the glen is bounded by lofty, precipitous moun-

tains

tains of micaceous ſhiſtus; but this ſoon diſappears, as the glen changes its direction, running N. N. E. and S. S. W.: then the mountains are formed of granite ſimilar to that of Goatfield. In ſeveral places of the glen fragments of baſalt occur; demonſtrating the preſence of veins traverſing the granite, as we have already obſerved upon Caime-na-callich and Glenroſa. Upon one ſide of the glen we obſerved a narrow valley, into which we entered, but found that the granite was ſtill the prevailing rock. At one place, indeed, I diſcovered great maſſes of porphyry; but I could not detect them *in ſitu*. It is probable, however, that it forms veins running in the granite, as the quantity of debris is too ſmall for ſuppoſing the exiſtence of ſtrata. After a very fatiguing walk, I reached the top of the glen, when I obſerved a conſiderable plain, in which is ſituated a lake, about a mile long and half a mile broad, which is named Loch-Tan. It is bounded upon two ſides by lofty granite mountains; but is open towards the others; one leading to Glen-Erſay, the other to Catacol. The margin of this partakes much of the ſterility of the ſurrounding ſcenery: vegetation hardly ſhews its head: a few lichens and tufts of heather are the only ornaments of which it can boaſt:

——————— A joyleſs coaſt.
Around a ſtormy lake,

Yet

Yet here the grandeur and fublimity of the furrounding granite mountains, envoloped in clouds and mift, excited in my mind a vaft variety of ideas; for,

> Surely there is a hidden power that reigns
> 'Mid the lone majefty of untam'd nature,
> Controlling fober reafon.

Upon afcending the granite mountains on the eaft fide of the loch, I obferved confiderable quantities of the debris of bafalt upon the top of the mountains, fhowing that the veins had reached to the very fummit *.

I walked onward to Glen-Erfay, and, in my way, obferved large blocks of a beautiful dark leek-green coloured pitchftone-porphyry, remarkable not only for the number, but alfo for the fize and beauty, of the cryftals of felfpar. I was not fo fortunate as to find it forming a fixed rock in the neighbouring granite mountains; yet it is probable that future obfervers may difcover it in veins, fimilar to that obferved on the fide of Caime-

* Sauffure obferved fragments of greenftone upon the fummit of Mont Blanc; very probably originating from a vein of greenftone which reached to the fummit of this great mountain. Voyages dans les Alpes, tom. 7me, p. 280—288.

Caime-na-callich. Some mineralogiſts will rather be inclined to ſuſpect that it alternates with granite: as this is ſaid to be the diſpoſition which it affects when among the granite mountains of other countries. According to Charpentier †, who made this obſervation, porphyry containing pitchſtone alternates with granite near Meiſſen in Saxony. Dr. Mitchell, who was lately on the particular ſpot deſcribed by Charpentier, informs me, that he could not obſerve any ſuch alternation, and therefore preſumes that the obſervation of Charpentier is erroneous. Having reached the ſide of Glen-Erſay, I obſerved it taking its riſe from the lower part of Caime-na-callich and the neighbouring mountains, and running, in an irregular courſe, towards the ſea. It is ſaid to be nine miles long, and is reckoned the moſt extenſive glen in the iſland. Its ſides and bottom are formed of granite, which continues until we come within a mile of the lower extremity of Loch-Erſay, when ſtrata of micaceous and talcaceous ſhiſtus make their appearance. Theſe ſtrata continue to the entrance of the glen on the ſea-ſhore; and here they are covered and ſucceeded by red argillaceous ſandſtone and ſandſtone breccia.

† Charpentier Mineralogiſche von Churſachſen, § 63.

As I had an opportunity, upon my former viſit to this iſland, of walking along the ſhore from Catacol to the entrance of Glen-Erſay, I will now ſhortly mention the nature of the rocks that occur in this tract, and then continue the deſcription onwards to the other parts of the iſland.

From Catacol to Whitefarland, a farm belonging to Fullerton of Kilmichael, the cliffs are low, compoſed of micaceous ſhiſtus, but defended from the action of the ſea by intervening ſea-banks ſimilar to thoſe noticed between Catacol and Loch-Ranza. Near to the farm of North Tundergay, I obſerved a remarkable vein of baſalt penetrating the micaceous ſhiſtus. The micaceous ſhiſtus is much waved; but, as it approaches the ſide of the vein, it loſes its ſhining glimmery appearance, breaks into thick plates, and, where in immediate contact with the baſalt, it forms a compact kind of ardeſia. The vein, as it riſes from the ſea, is fairly croſſed by a ſpecies of micaceous ſhiſtus approaching to breccia; and here alſo the baſalt and micaceous ſhiſtus are much jumbled together, and ſome pieces of the vein are apparently inſulated in the micaceous ſhiſtus. Here, then, we have two facts; the former, the apparent tranſition from micaceous ſhiſtus to ardeſia; the other, maſſes of baſalt immerſed in the micaceous ſhiſtus, in a ſimilar manner to the baſalt I obſerved embedded in the granite upon the eaſt ſide of Glen-Roſa. At Whitefarland there is a conſiderable extent of

natural

natural wood, which adds greatly to the beauty of its appearance, which is much heightened by the lofty granite mountains that bound it on one hand, with the ſea and long-extended iſthmus of Cantyre on the other. From this to Imachar the ſame micaceous ſtrata continue, forming beautiful cliffs and conſiderable ſea-beaches. At Imachar the micaceous ſhiſtus is undulated, and traverſed with quartz, ſo as to give the whole a kind of maculated aſpect; and it continues to form cliffs until we come to the ſtream which iſſues from the entrance of Glen-Irſa. Upon one ſide of this ſtream I obſerved primitive ſhiſtus, but upon the oppoſite ſide ſandſtone cliffs make their appearance. Theſe cliffs have a conſiderable beach interpoſed between them and the ſea; and the ſtrata of ſandſtone and ſandſtone breccia are elevated at a greater angle than any I have obſerved in the other parts of the iſland. The retreat of the ſea from theſe cliffs is not only marked by the conſiderable beach we have juſt mentioned, but alſo by the caves which are diſperſed in them. Theſe cliffs ſoon diſappear, when porphyry is to be obſerved; but we can only trace it a little way, the covering of graſs preventing any further examination. The country is now low and flat, ſo that we have an eaſy walk to the houſe of the Shiſkin; and the only rock I noticed was the red argillaceous ſandſtone, which I obſerved in the bottom of ſeveral burns: thus intimating that the whole ſtrata over which I had

paffed, after leaving the porphyry, was fandftone. At the Shifkin the land is low and flat. The mountains in the neighbourhood have a different appearance from thofe about Loch-Ranza; are lower; their fides lefs precipitous; in fhort, have much of the general afpect of thofe about Glencloy, all announcing a change in their compofition. We have a good opportunity of determining the truth of this conjecture, in the Clachen glen, which is but a fhort diftance from the Shifkin. The fandftone ftrata, which we have juft mentioned as forming the low country around the Shifkin, ftretches up the glen for a confiderable way. At one place, on the fouth fide, I obferved a confiderable ftratum of limeftone, which is covered, and even, in fome places, intermixed, with fandftone breccia; and, nearer the upper extremity of the glen, fhiftofe clay, richly impregnated with iron, makes its appearance. As we proceed upwards the glen becomes very deep; and, upon the north fide, confiderable rocks of clay-porphyry occur, apparently covering the fandftone, as I conjectured may be the cafe at Glencloy and Corygills. As we approach ftill nearer to the upper extremity of the glen the fandftone difappears, when a fienite, fimilar to that at the head of Glencloy, is to be obferved, and, fo far as I could determine, rifes to the fummit of the neighbouring hills.

About

About two miles N. W. from the Shifkin, after paffing through a moorifh flat, we come to Tormore, which is the promontory of this plain. Here are cliffs of confiderable extent, which contain a range of extenfive caves, celebrated by tradition as the refting place of Fingal, the father of our great Offian, who, it is faid, ufed to retire here after the fatigues of the chace. In the farther extremity of the greateft, or what is called the King's Cove, are a few fcratches, made by idle fifhermen or fmugglers, which, by fome, have been referred to the Fingalian age.

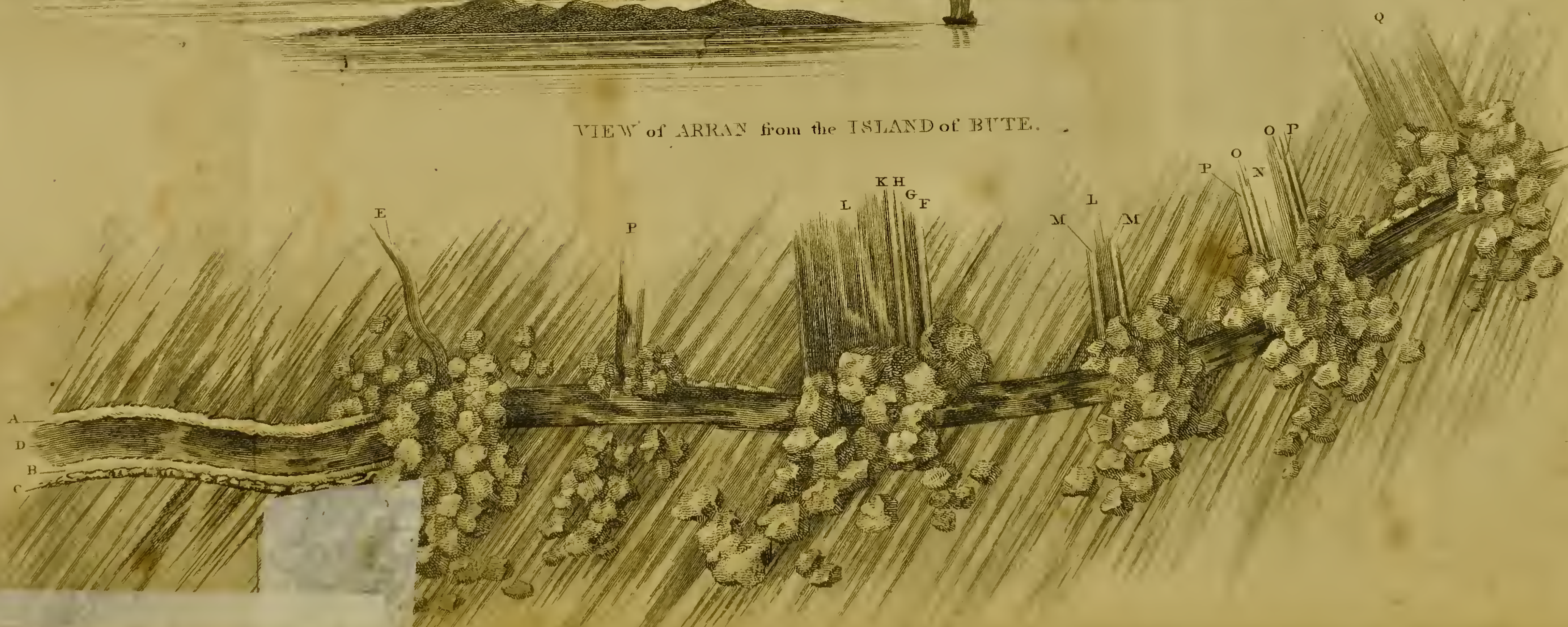
As the appearances at this promontory are very interefting, I fhall make the defcription as diftinct as poffible; and, to be regular, I fhall begin at the north-eaft end, or Machry Bay, and fo on to Drumoodon point. The bay is of confiderable extent; and the fhore, all around to Irfa, is formed of fandftone. The bottom of the bay is a low fandy beach; but, towards Tormore, it rifes, forming cliffs, which are continued all around to Rue-varey, or the columnar promontory, for the fpace of about a mile and a half: and thefe cliffs are from forty to one hundred feet high. Between the cliffs and the fea there is a confiderable fandftone beach, which is remarkable for the great variety and the number of veins that traverfe it, in different directions: thefe, at firft fight, appear confufed; but

a little

a little attention ſoon diſcovers a beautiful and diſtinct diſplay of a moſt curious diſpoſition of rock. As the pitchſtone veins are the principal objects of curioſity, I will deſcribe theſe firſt; and, to make the detail accord with the engraved plan, I will begin from the extremitv of the great pitchſtone vein as it riſes from the ſea, and ſo trace it back to near Machry Bay.

The great vein of green-coloured pitchſtone, D, as it riſes from the ſea, is ſeveral feet wide, has a conſiderable inclination to the horizon, is ſlightly bent in its courſe, and traverſes the common red-coloured argillaceous ſandſtone. It has, for ſome yards, the character of a *ſtratified vein;* that is, it contains layers or ſtratulæ of different ſubſtances depoſited in the ſame fiſſure along with the pitchſtone. Upon the ſide of the vein next the ſea, there is a layer, A, of a ſubſtance which appears inclined at an angle of 60°, dips in the ſame direction with the pitchſtone D, and has a ſimilar curve. It is not untike a compact ſandſtone; but it is probably of the ſame nature with B on the oppoſite ſide of the vein, only more altered by the action of the weather and the ſea. Upon the oppoſite ſide of the pitchſtone, we obſerve a layer, B, which appears to be of the nature of hornſtone, or, rather, verging to quartz: it has a ſimilar curve and dip with the pitchſtone. Immediately beſide it there

VIEW of ARRAN from the ISLAND of BUTE.



there is a thin layer of bafalt, C, which is decompofing in balls; and this, again, is bounded by the common argillaceous fandftone ftrata. The vein continues thus ftratified for about twenty yards, when the layers, A, B, C, appear to come nearly horizontal, and foon they entirely difappear under the debris. Further on, where the pitchftone is almoft free from the covering of debris, it appears to be bounded on both fides by the common argillaceous fandftone; yet this is doubtful, as there may be fmall portions of the other ftratulæ, which the debris prevents us from obferving.

At a little diftance from where the fandftone appears to form the fide of the great vein D, we obferve E, which is a vein of rock fimilar to that of B, is from fix to eight inches wide, and is waved in its courfe. At fome diftance from this, there is a vein of bafalt, P, about five feet wide, running nearly E. and W. which is much the fame direction with the laft mentioned vein. The next vein which we meet with is about thirty feet feet wide; runs N. W. and N. and N. E. and E. which is nearly in an oppofite direction to the great vein. Upon one fide, there is a layer, F, of a wax-coloured fubftance, intermediate between hornftone and pitchftone; next, is a layer, G, of high olive-green coloured pitchftone, about two feet wide; again, we have a layer, H, about half a foot wide, of the fame pitchftone-

hornftone,

hornſtone as F; then, a layer of indurated clay, K; and, after this, the whole vein is formed of baſalt, L. The ſandſtone which bounds this vein, in place of being red, the uſual colour, is partly a yellowiſh-white colour. I endeavoured to diſcover its junction with the great vein D, but without ſucceſs, owing to the great covering of debris: I obſerved it, however, upon the oppoſite ſide of D, but at a diſtance, entering into the neighbouring ſandſtone cliffs. At a little diſtance from this, we meet with another remarkable vein: the ſides, M, M, are of baſalt *; but the middle, L, is of breccia †. Still nearer to Machry Bay, another curious vein is to be ſeen: it is about eight feet wide; the ſides, P, P, are of fine white-coloured argillaceous ſandſtone ‡; next, are two layers, O, O, of baſalt ‖, which

* This baſalt does not differ from that from the ſouth ſide of Glencloy, deſcribed at page 53.

† This breccia is formed of variouſly-ſhaped maſſes of common and arenaceous quartz, and indurated clay, connected by a baſis which is only an agglutination of ſmaller particles of the ſame kind.

‡ This ſandſtone only differs from the ſtratified kind by its having a white colour.

‖ This baſalt has a black colour; and has, diſperſed through it, cryſtals of hornblende, calcareous ſpar, aud iron pyrites: this laſt, by decompoſition, often gives the whole a brown colour.

which decompofes in balls; and the middle, N, is formed of a rock which has cryftals of felfpar and rounded pieces of quartz, immerfed in a bafis that feems one of the gradations from pitch-ftone to hornftone. The laft vein, Q, which I obferved running, in a crofs direction, to the great vein of pitchftone D, is about ten feet wide, and entirely compofed of green-coloured pitchftone.

The great vein continues vifible for a little way after paffing the vein Q, and is nearly of the fame diameter; but, as we approach very near to Machry Bay, it is not to be further traced, on account of the covering of debris. Near to its termination, however, I obferved the hornftone pitchftone fubftance forming a layer upon one fide, and even, in fome places, intermixed with it.

I have to regret that this interefting piece of mineralogy is fo imperfectly detailed; yet I truft it will ferve to excite others, better qualified, to give it a more particular examination. I would particularly recommend an attention to the appearances prefented by the junction and croffing of the veins; which I had not an opportunity of exploring, on account of the great covering of debris: a hindrance which fome future action of the fea may remove.

The next object which claims our notice, is, the determination of the relative poſition of the ſandſtone and porphyry. The cliffs, beſides the ſandſtone, of which they are principally compoſed, are, in ſome places, varied by a clay-porphyry, very ſimilar to that of Glencloy; with this difference, that the cryſtals, felſpar and quartz are larger. The porphyry, ſo far as I could determine, does not ſeem to lie on the ſandſtone, but merely to ſkirt it. Several baſalt veins are to be obſerved traverſing it, in different directions. One vein, about ſeven feet wide, runs through it in a perpendicular direction, and gradually narrowing towards the top of the cliffs, when it is loſt among the ſandſtone that lies behind. Another runs more in a horizontal direction, and between the ſandſtone and clay-porphyry. Another vein, which is nearer to Machry Bay than the other two, is to be obſerved running with porphyry on the one ſide, and ſandſtone on the other: it ſoon divides; one branch penetrating the porphyry, the other running between the ſandſtone and porphyry.

To the W. of the King's Cove, I obſerved great maſſes of green-coloured pitchſtone ſcattered upon the ſhore; but I could not diſcover whether they belonged to the great vein D on the other ſide of the caves, or had been ſeparated from other veins or ſtrata. Upon the top of the cliffs, at the ſame place, I obſerved

ferved a variegated pitchftone, which was decompofed, in fome fpecimens, almoft to a brownifh-white earthy powder, cropping through the grafs; but I could not difcover whether it formed a vein or ftratum.

From this to within a fhort diftance of the columnar promontory of Drumoodon, the cliffs are of fandftone; but, in fome places, they appear covered with a porphyry: of this, however, I cannot fay any thing fatisfactory. I obferved many bafaltic veins traverfing this fandftone; and, upon examining the connection of the veins and ftrata, I found the bafalt and fandftone, at their junction, in feveral places, intermixed; and alfo the bafaltic veins, befides the angle they form with the horizon, had a confiderable inclination of themfelves.

At a little diftance from the columnar promontory, I obferved low, fhelving rocks of clay-porphyry, which extend beyond the point Rue-Varey on the one hand, and feem to be connected with the porphyry on the other. The promontory is a ftriking object; is pretty high; and compofed of red-coloured argillaceous fandftone, which is covered by irregular columns of a porphyry which, in fome places, has much refemblance to bafalt-porphyry, in others is evidently clay-porphyry. This fact is a prefumptive proof that the conjecture I have

O 2 made,

made, with regard to the ſituation of the porphyry of Glencloy and Corygills, may be true.

Having paſſed Rue-Varey, which is the moſt weſtern point of Arran, we came to the farm of Drumoodon, which is ſituated upon the ſea-ſhore, with a conſiderable ſandy beach before it, and, behind, the ſandſtone cliffs are ſtill continued. Here we find, reſting upon the ſandſtone, a curious ſpecies of rock, having a tendency to ſplit into columns; but of which I cannot give a determinate opinion, as I do not find any deſcription, in the mineralogical works I have conſulted, that correſponds with it. I have marked it, in the ſhort deſcription that is detailed in the following chapter, as intermediate between baſalt and ſandſtone. Theſe cliffs become gradually lower, and at length diſappear, being ſucceeded by an extenſive beach covered with fragments of the neighbouring rocks. After paſſing this beach, which forms one ſide of the plain of the Shiſkin, conſiderable cliffs now riſe before us, which are formed of clay-porphyry of conſiderable height, but much ſplit by the action of the weather, which gives an indiſtinct idea of ſtratification, ſimilar to the granite obſerved in the Cory-Dain, at the head of Glen-Roſa. Theſe cliffs contain ſeveral caves, but none of them are of any conſiderable ſize; and the ſhore is covered with great maſſes,

maffes, which have been feparated from the cliffs by the action of the fea and weather. Thefe maffes have a peculiarity of form, which characterifes the rock from which they have been feparated. This remark may appear fanciful; but feveral circumftances lead me to imagine, that one accuftomed to obferve with attention the debris upon the fea-coafts, &c. may often guefs as to the peculiar nature of the rocks themfelves, by obferving the fhape of the fragments. The whole fhore, to Tory-Lin, appears to be compofed of clay-porphyry, and in fome places fandftone is to be obferved, and both are traverfed with veins of bafalt. I picked up fragments of dark leek-green-coloured pitchftone, in different places, among the debris of the neighbouring rocks; but had not leifure to determine its fituation. From the Shifkin to Tory-Lin, there is a tolerable road; which is a rarity in this ifland, and extremely agreeable to the traveller, after having fcrambled around the fhore from Brodick Bay. The land now becomes lower, and has more of the rural appearance of the Lowlands of Scotland: agriculture is followed with fome fpirit, and even many of the fea-beaches are cultivated.

Tory-lin confifts of a few houfes, pleafantly fituated in a hollow, at a little diftance from the fea fhore, and furrounded

with

with ſandſtone hills. In the burn which runs by the houſes, I obſerved veins of baſalt traverſing the ſandſtone in different directions, and amongſt the bowlder ſtones which cover its bottom, fragments of a light blackiſh green-coloured pitch-ſtone preſented themſelves, ſhowing the exiſtence of veins or ſtrata of that foſſil in the neighbourhood. Upon the ſhore a curious ſpecies of porphyry, (different from wacken-porphyry,) makes its appearance, and ſeems to be traverſed with veins of common baſalt, which are here of very great ſize.

On my ſecond viſit to Arran, I walked a-croſs from Tory-Lin to Lamlaſh harbour, which gave me an opportunity of obſerving a part of the iſlands, with which I was before un-acquainted. I will therefore ſhortly mention what occurred in that route; before proceeding to mention the very few ob-ſervations I made on the ſouthern part of the iſland. After leaving Tory-Lin, we aſcend for ſome time over the uſual red-coloured argillaceous ſandſtone, it at length diſappears, and the higher grounds are formed of porphyry. This porphyry continues until we come to the farm of Achariach, when red-coloured argillaceous ſandſtone is to be obſerved in the bot-tom of a burn, and is apparently traveſed by a vein of white-coloured ſandſtone. As we proceed onwards, we aſcend ſome high grounds, where the porphyry again appears, and it now

continues

continues all the way to the hills upon the ſide of Lamlaſh bay. Theſe hills are compoſed of white-coloured ſandſtone at the top, but lower down of common red-coloured ſandſtone.

The ſhore from Tory-Lin to the Benin-Head, the moſt ſouthern part of the iſland, is principally compoſed of ſandſtone, traverſed with veins of baſalt, which are ſometimes of great ſize, and run in a great variety of directions. The hills back from the ſhore appear to be entirely compoſed of porphyry*, but are not of any great height. The whole country to the Benin-head is conſiderably cultivated, and is here and there diverſified with ſmall villages, which give to the whole a picturesque feature, which we have ſeldom an opportunity of obſerving in this iſland. At the Benin-head, the cliffs are of conſiderable height, and are compoſed of ſandſtone, porphyry, and baſalt. The porphyry and baſalt have a tendency to the columnar form, and both are traverſed by baſalt veins, which are often of a great ſize.

From this to Whiting Bay, the cliffs are low, formed of ſandſtone, and traverſed with baſalt veins, which run in a great

* I find in my notes, that ſienite is marked as one of the rocks of this part of the country. I am now ſomewhat doubtful of that fact, and will therefore leave it as an object for future enquiry.

great variety of directions. The hills, however, up from the ſhore, now change their appearance, preſenting broad, bare, perpendicular faces, ſimilar to thoſe which occur in all baſaltic countries ; and upon examination, we find them to be compoſed of various ſpecies of baſalt, * lying upon a red-coloured ſandſtone, which is intermixed with grunerde, and a grey ſhiſtoſe clay. This baſalt is often columnar, and the perpendicular crags, being ſcattered in various directions, and often riſing in groupes above each other, have a pleaſing effect. Near to Whiting bay, there are conſiderable rocks of greenſtone of nearly the ſame ſpecies with that found near Corygills ; it is not in any conſiderable quantity, and appears to be the rareſt rock in the iſland.

At Whiting bay, the cliffs diſappear, and are not to be obſerved until we come to the entrance of Lamlaſh bay ; in their place we have an extenſive beach, bounded by gradually riſing ſandſtone hills, much traverſed with baſaltic veins. When the tide ebbs, the bottom of the bay exhibits a moſt aſtoniſhing collection of baſaltic veins, which have been laid bare

* Stucke, a German chemiſt, on breaking a certain cellular baſalt, found the cells to contain water. He analyſed 20 ounces of this water, and found it to contain fourteen and a half grains of ſilex. *Stucke* Unterſuch. 119. *Kirwan*, Geological Eſſays, p. 118.

bare by the action of the fea; here they are to be feen running in every direction, meeting and croffing each other in a moft curious manner; in fhort, this is one of the beft parts of the ifland for obferving the various croffings, &c. of thefe fingular appearances *. At the entrance of the bay of Lamlafh, the fandftone forms confiderable cliffs, which continue a fhort way of confiderable height, but are gradually lower as we approach the village of Lamlafh, where there is an extenfive flat beach. Thefe cliffs are alfo traverfed with veins of bafalt, and in fome places a few hundred yards from the fhore, I obferved many detached maffes of green pitchftone, indicating its exiftence in the neighbourhood.

Lamlafh bay, which is the beft harbour in the ifland, and one of the beft in the Firth of Clyde, is of a femi-circular fhape, and is formed in part by Holy ifland or the ifland of Lamlafh, which lies acrofs it, leaving two entrances, one from the north, the other from the fouth, which laft is always preferred

* It will be fomewhat difficult to explain the appearance of fo many veins in fo fmall a fpace of ground as Whiting bay, according to the Wernerian Theory. For furely had all thefe been at one time open fiffures, the fandftone would not at the fame time have fupported itfelf. Sauffure, imagines, that this objection may be removed, by fuppofing, that thefe fiffures were formed fucceffively.

ferred by mariners. It is bounded upon the Arran ſide by hills of red and white ſandſtone, traverſed by baſaltic veins. Upon the eaſt ſide of the bay, attempts have been made to diſcover coal, but without ſucceſs.

Lamlaſh or Holy iſland, is about three miles long, and half a mile broad, precipitous on the eaſt, alſo conſiderably abrupt on the weſt ſide, but the north and ſouth ends are low. It is compoſed of red-coloured ſandſtone, which is in ſome places formed into ſmall caves; one is celebrated for being the reſidence of the holy diſciple of St. Columba, St. Mool-jos, or the ſervant of Jeſus. This ſandſtone is covered in many places with a ſpecies of baſalt, very ſimilar to that near Whiting bay, and with difficulty diſtinguiſhable from ſandſtone. I have been very much at a loſs with regard to the particular denomination to be given to this rock; and I muſt ſtill remain in doubt †. It forms in many places regular columns, generally ſix-ſided, which riſe range above range, giving a faint idea of the ſtupendous ſcenery of Staffa or Bo-ſhela.

† Sauſſure mentions a baſalt much reſembling ſandſtone, having a priſmatic rhomboidal form, and containing hornblende cryſtals. Obſervations ſur les Collines du Briſgau—Journal de Phyſique, An Deuxieme, p. 329.——Nay, even ſandſtone has been found columnar: thus the columnar boulaſtein, found in Iceland, is a ſandſtone.—Eggert Olafsen Reiſe durch Iceland.

la. Upon the weſt ſide, the columns are of greater ſize than upon the eaſt, and the ſame matter appears to form the ſummit of the iſland, which is reckoned about ſeven hundred feet high. Upon the ſouth-eaſt part of the iſland, I obſerved a rock principally formed of cryſtals of hornblende, which is in ſome places traverſed by baſalt veins*, and alſo ſtratified with the common ſandſtone; and towards the ſouth-weſt extremity, baſalt veins are ſeen traverſing the ſandſtone.

* This baſalt has a very great ſpecific gravity, owing to its being abundant in iron.

ARRAN.

CHAP. VIII.

Defcription of the Foffils, occurring in the preceding Chapter.

PITCHSTONE—*From Tormore.*

THE following feries of foffils affords us a curious example of the gradations, which we often obferve between the different kinds of rock. Thefe gradations were either overlooked, or but vaguely underftood, until the time of Werner, who by the beautiful difcovery he made in thus tracing the fteps of nature, attracted the attention of mineralogifts. An eminent mineralogift of our own country, has made great progrefs in this interefting enquiry, and it is to be hoped, he will foon gratify us with the refult of his labours.

N°

No. I.

PITCHSTONE—*from the great vein* D.

Colour. Brownifh.

Luftre. Little glancing, and greafy.

Tranfparency. None.

Fracture. Uneven, approaching the fplintery.

Hardnefs. Gives a few fparks with fteel.

Quartz, and a reddifh fubftance like garnet is difperfed through it.

Nº II.

PITCHSTONE *paffing to Hornftone.*

Colour. Light wax yellow, yellowifh green, weak reddifh brown.

Luftre. None.

Tranfparency. None.

Fracture. Even, fplintery, fometimes uneven.

Hardnefs. Hardly touched by the knife.

Smell. Gives a ftrong earthy fmell when breathed on.

Fufibility. At 55° was covered with a flight enamel; at 69° became

became white, ſlightly ſoftened, and was then ſomewhat porous. A fragment from a ſix-ſided column ſoftened at 81°, and at 118° a compact brown vitreous maſs was formed, which had interſperſed white grains.

By decompoſition it acquires a white, and in ſome varieties a brick-red colour. It has diſperſed through it cryſtalliſed and amorphous quartz, chalcedony, a very few cryſtals of white felſpar, calcareous ſpar, and alſo minute dark leek-green-coloured cryſtals, probably pitchſtone.

N° III.

Foſſil which appears pretty nearly of the nature of Hornſtone, or rather verging a little to Quartz—from the ſtratulum B.

Colour. Pale blackiſh brown; or, dark grey, approaching to black.

Luſtre. Very little glancing.

Tranſparency. A very ſlight degree at the edges.

Fracture. More or leſs fine ſplintery, and very compact.

Hardneſs. Gives fire plentifully with ſteel.

Pieces of quartz are diſperſed through it, as in the former; and a few cryſtals of felſpar now and then occur.

N°

N° IV.

Foſſil ſtill more nearly approaching to Quartz, which is intermixed with the green pitchſtone of the great vein D.

This ſpecies of rock differs little in colour from the preceding; but has more luſtre and tranſparency, and is a little harder. It acquires a white cruſt by the action of the weather. It has alſo, interſperſed, cryſtals of quartz.

OBSERVATIONS.

Theſe different gradations are all to be obſerved in the ſame vein, and appear to graduate or paſs into each other. Thus, the firſt, or browniſh-coloured pitchſtone, by its little luſtre, ſeems verging to the ſecond; and, in reality, we often obſerve, in the ſame ſpecimens, the one paſſing into the other. The pitchſtone-hornſtone ſubſtance, N° II. as its name implies, has partly the character of the pitchſtone, and partly that of hornſtone. The degree of fuſibility intimates that it is ſenſibly different from the pitchſtone, yet not ſufficiently refractory for hornſtone. Klaproth found a ſubſtance of this kind fuſible; and Mr. Kirwan mentions a greeniſh-white hornſtone, from Lorraine, which, from its being fuſible, ſeems analagous to this.

We

We are ſometimes ſo lucky as to find ſpecimens where the ſecond paſſes into the third; and often we obſerve the third paſſing to the fourth.

Theſe four kinds of rock, then, preſent to us a complete gradation from pitchſtone to hornſtone; and we have a few ſteps towards quartz. In other countries, we have accounts of nearly ſimilar appearances; and theſe I may ſhortly mention, as they will add freſh intereſt to the detail we have now given. Reuſs informs us, that he obſerved pitchſtone paſſing, by various ſtages, to hornſtone, at Garſeback, near Meiſſen *. Eſthner remarks, that the Saxon pitchſtone paſſes ſometimes to hornſtone †. and Mr. Kirwan, in his Elements of Mineralogy, obſerves that it paſſes to hornſtone.

CLAY PORPHYRY, *when paſſing to hornſtone—Tormore.*

Colour. Greyiſh.

Luſtre. None.

Tran-

* Sammlung Naturhiſtoriſcher Aufsatze, &c. von Franz. Ambros Reuſs, § 362.

† Eſthner, Mineralogie, B. ii. § 445.

Tranſparency. A little at the edges.
Fracture. Even, paſſing to the fine ſplintery.
Hardneſs. Gives a few ſparks with ſteel.

It contains, immerſed in the baſis, cryſtals of common red felſpar, and white felſpar approaching adularia. The cryſtals are of conſiderable ſize; and this is one of the principal diſtinctions between this ſpecies and ſome of thoſe found in Glencloy. It decompoſes, in the form of a brick-red cruſt, ſimilar to ſome of the ſtones which are intermediate between pitchſtone and hornſtone.

In other ſpecimens, the porphyry, as it comes in contact with the veins of baſalt, has a baſe conſiderably reſembling it; and at the columnar promontory of Drumodoon, the ſpecimens often cannot be diſtinguiſhed from what is called trap-porphyry.

A ſubſtance intermediate between ſandſtone and wacken, having a tendency to the columnar form—Farm of Drumoodon.

Colour. Yellowiſh.
Luſtre. None.

Tranſparency. None.—It feels much like a ſandſtone.

Fracture. Even earthy, with the appearance of rounded concretions.

Hardneſs. Gives a few ſparks with ſteel: but it contains confuſed fragments of quartz, which may have been the cauſe of this.—Emits a ſtrong earthy ſmell, when breathed upon *.

Fuſibility. Melted at 79°.

OBSER-

* Lampadius has diſcovered that hornblende contains charcoal diffuſed thro' it; and Mr. Kirwan has ſhown that ſome ſpecies of pitchſtone contain it. It is conjectured that it may exiſt in other foſſils, and cauſe the peculiar earthy ſmell which we perceive by breathing upon them.

OBSERVATIONS TO BE MADE,

FOR THE FARTHER ELUCIDATION OF THE

MINERALOGICAL HISTORY OF ARRAN.

VEINS.

I. TO examine the bafalt, wacken, and pitchftone veins, (which occur in fo many parts of the ifland,) with a view to difcover if they be *ftratified.* We fhould defcribe accurately the difpofition of the ftratulæ of fuch veins, as it will enable us to determine their relative antiquity; thus, according to Werner, the parts neareft the fides of a vein are the moft antient, thofe in the middle the moft modern, and the intermediate of a middle age.

II. In the examination of veins, it will be of confequence to obferve how they crofs each other; which, Mr.

 Werner

Werner remarks, will enable us to determine their relative antiquity: thus, if two veins crofs each other, the moft modern is that which croffes the other; and, of two veins, the one which interrupts or ftops the other is the moft antient.

III. To examine carefully the country in the vicinity of veins, fo as to determine if there be any beds of a matter fimilar to that which fills the veins. It follows, from Mr. Werner's theory, that we fhould generally obferve fuch appearances.

IV. To examine if the fides of the veins be more or lefs hard; where in contact with the granite, micaceous fhiftus, porphyry, fienite, or fandftone.

V. To examine the bafalt, and other veins, with a view to obferve whether they contain petrifactions, or even wood unaltered; alfo, if they contain boulder ftones.

STRATA.

STRATA.

VI. To determine the direction and inclination of all the ſtrata throughout the iſland; ſo as to know whether they have much the ſame general arrangement, and if they are frequently ſituated in a ſimilar manner with the ſtrata at the mouth of Loch-Ranza.

VII. To examine particularly the ſtrata of ſienite; ſo as to diſcover its connection with the granite, porphyry and micaceous ſhiſtus.

VIII. In examining the great glens, as Glen-Roſa, Sanicks, &c. it will be of conſequence to examine very particularly as to the diſpoſition of the granite in ſtrata; thus either to confirm or refute the obſervations on the ſtratification of the granite.

IX. To diſcover whether the porphyry, which is obſerved among the granite mountains, be diſpoſed in veins or ſtrata.

X. To

X. To endeavour to difcover the fituation of the hornblende and paliopetre which is obferved in blocks at the entrance of Glen-Rofa.

XI. In traverfing the hills of micaceous fhiftus, to be careful in obferving if any rocks of trap formation occur in *ftrata*.

XII. To determine the pofition of the breccia, with regard to the other rocks, at the head of Glencloy; and alfo, to examine, more particularly, the extent and pofition of the breccia of South Glen-Sanicks.

XIII. To examine very particularly the appearance of the granite, at its junction with the micaceous fhiftus and ardefia, in different parts of the ifland. In this inveftigation it will be neceffary to obferve, 1. If the fhiftus, where in immediate contact with the granite, be not harder than it is at a diftance. 2. If veins of granite are to be obferved ftretching from the granite, and traverfing the fhiftus. 3. If the granite veins have the fame grain with that of the granite of the neighbouring mountains. 4. If the granite and fhiftus be irregularly intermixed at their junction. 5. If the granite and fhiftus ever alternate

alternate with each other. This Werner confiders as a rare appearance. I have not obferved it in Arran. 6. If the micaceous fhiftus, where it covers the granite, can be obferved gradually changing its character, and at laft, where in junction with the granite, not diftinguifhable from it: a fact which has been obferved in other countries, and demonftrative of the granite and fhiftus being formed nearly at the fame time.

BUTE.

BUTE.

CHAP. IX.

Outline of the Mineralogy *of the Island of* Bute; *with Observations upon the Formation of the Bed of the* Clyde, *aud an Account of the Route from* Bute *to the Island of* Jura.

THIS iſland is about eighteen miles long; and the broadeſt part, extending from eaſt to weſt, is five miles. It is ſeven miles diſtant from the iſland of Arran; but is ſeparated from the diſtrict of Cowal by a channel which is only about half a mile broad, and, in ſome places, ſixteen fathoms deep. Towards the north end it riſes into hills of conſiderable height; but theſe are neither ſufficiently high nor extenſive to afford ſcenes ſo ſublime as thoſe which characteriſe the mountains of Arran. The ſouthern part of the iſland is, in general, (excepting at its moſt ſouthern extremity,) low, well cultivated, and, in ſeveral places, beautifully ornamented with wood, particularly

ticularly near to Mount-Stewart, the charming ſeat of the Marquis of Bute. Although this iſland be deſtitute of fine mountainous ſcenery; yet, the extenſive cultivation, and the general appearance of buſtle and life, form a ſtriking contraſt to the lone waſtes of the iſland of Arran.

Rotheſay, the only town in the iſland, is pleaſantly ſituated upon the ſhore of a conſiderable bay of the ſame name. It is principally ſupported by the herring fiſhery, and a very conſiderable cotton manufactory.

The iſland ſeems to be traverſed by three irregular vallies, which run from eaſt to weſt. One croſſes the iſland at the town of Rotheſay; the ſecond at Kaimes Caſtle, in the north; and the other at Cil-Chattan, in the ſouthern part of the iſland.

The mineralogy of this iſland, ſo far as I examined it, does not appear to be particularly intereſting: but a cloſer inveſtigation may diſcover many things which eſcaped my notice; as I examined it in very unfavourable weather, and, beſides, had the misfortune to loſe the ſpecimens I had collected.

The whole of the iſland to the north of Rotheſay is compoſed of primitive rock, which riſes into conſiderable hills about Kaimes Caſtle, the ſeat of Lord Bannatyne. This half of the iſland is pretty nearly ſurrounded by the neighbouring land of Cowal, ſo that the ſea can have little power over its ſhores, which are indeed very low; but the narrow channel, as I have already remarked, is very deep. The ſtrata, in general, are, micaceous ſhiſtus, ardeſia, and ſhiſtoſe talc; and they alternate, and paſs into each other. Sometimes we alſo obſerve chlorite; which is either maſſive, or forms a ſpecies of ſlate; and not unoften I remarked quartz, more or leſs penetrated with the chlorite, forming a dark-green-coloured ſtone, ſimilar to that I found in Arran. In ſeveral places conſiderable veins of quartz are ſeen, traverſing the ſtrata in different directions; and ſometimes they exhibit curious phenomena. I obſerved upon the ſea-ſhore, about a mile and a half ſouth of Kilmichael ferry, a vein of quartz which deſerves to be particularly noticed. As it riſes from the ſea, it is very narrow; but it ſoon becomes wider, and then divides into ſeveral conſiderable branches, which traverſe the ſtrata in different directions. One of theſe branches preſents an appearance ſimilar to that obſerved in Glenroſa, in the iſland of Arran, and deſcribed at pages 38, 39. This branch, having traverſed the ſtrata for ſeveral feet, is interrupted by a maſs of micaceous ſhiſtus; but it again

gain appears at a little diftance, and ftill in its former direction. Maffes of micaceous fhiftus are alfo to be obferved in the midft of the quartz vein. The appearance of a mafs of micaceous fhiftus, which is a fufible ftone when compared with quartz, in the midft of a quartz vein, muft be confidered as decifive againft the theory of Dr. Hutton: for it is impoffible to fuppofe that it fhould remain unaltered in a heat capable of melting quartz, or keeping it in a foft ftate.

The bafaltic veins, which occur fo often in Arran, are alfo pretty common in this ifland, and are found from two to ten feet wide, traverfing the primitive ftrata in various directions; and I even noticed them upon the top of the higheft hills.

Near to Lord Bannatyne's caftle there are feveral flate quarries, which have been worked for fome time, and are ftill continued. Thefe flates, however, are not fo much ufed as thofe from Eafdale, which are, even here, preferred for economical purpofes. In fome parts of Germany, as at Ruhla *, they employ a compact micaceous fhiftus for the roofing of houfes;

 and

* Voight Mineral Reifen durch das Herzogth. Weimar. Th. 2. Se. 24.

and it is preferred to ſome kinds of ardeſia, from its great durability. Probably ſome ſpecies of micaceous ſhiſtus, equally uſeful with that uſed in Germany, may be found among the hills in the northern parts of the iſland. Mr. May, the chamberlain of Bute, informed me, that trials had been made for lead in the northern parts of the iſland, but without ſucceſs. This I reckon no ſatisfactory proof that lead is not to be found in the iſland; as, in all probability, the perſons, employed to make the trials, were but little verſed in the buſineſs.

The north ſide of Rotheſay bay is entirely compoſed of primitive rock, ſo is alſo the north ſide of Scalpa bay, which is ſituated upon the weſt ſide of the iſland, and nearly oppoſite to Rotheſay; but the ſouth ſides of theſe bays are compoſed of red argillaceous ſandſtone, and ſandſtone breccia. The junction of theſe primary and ſecondary ſtrata, is therefore to be looked for in theſe bays.

The country between Rotheſay and Cil-Chattan bay; which is the loweſt, moſt beautiful, and beſt cultivated part of the iſland; is compoſed of ſtrata of red argillaceous ſandſtone, and ſandſtone breccia, alternating with each other, and both are traverſed with baſaltic veins. Upon the ſhores, on both ſides of this part of the iſland, there are inland cliffs, ſimilar to thoſe near

near the north end of Arran, and in feveral places we remarked banks of coral and fea fhells *, confiderably above the high water mark. Thefe appearances, as well as thofe that occur in Arran, are proofs of the land gaining on the fea.

From Cil-chattan bay, to the fouthern extremity of the ifland called Gurroch-head, the face of the country is much altered; it now becomes nearly as high as in the north end, rifing into irregular hills with abrupt perpendicular crags, that are almoft characteriftic of a bafaltic country. From the little opportunity I had of obferving this part of the ifland, I can only fay in general that it is compofed of argillaceous fandftone, ftratified with bafalt, and traverfed by bafaltic veins. The bafalt is fometimes columnar, and frequently contains much hornblende. I was told that lime had been found in this part of the ifland.

GENERAL

* Thefe banks are ufually made of the *Millepora polymorpha*, of which there are many curious varieties.

GENERAL OBSERVATIONS ON THE CLYDE.

Having now finiſhed the outline of the mineralogy of the iſlands in the Clyde, I ſhall make a few obſervations upon the mode which nature appears to have followed in the formation of the bed of the river, the rocks and iſlands.

The appearance of iſlands in any quarter of the globe, naturally ſuggeſts to the mind, the idea of ſome powerful agent which has convulſed and broken the ſolid land, and formed it into detached maſſes. This opinion is not fanciful, for appearances, in many countries, ſhow us, that the greater number of iſlands have been formerly joined together, and muſt have conſtituted part of the adjacent continent. Thus, if we examine the rocks upon the oppoſite ſides of the Clyde, we ſhall find a great ſimilarity in their nature. 1. At Campbeltown, which is only a few miles from the extremity of the iſthmus of Cantyre, we obſerve a ſmall portion of ſecondary ſtrata, which correſponds to that upon the oppoſite coaſt of Ayrſhire. 2. The rocks upon the north and ſouth ends of the iſland of Arran correſpond exactly with the ſtrata upon the north and ſouth ſides of the Clyde. 3. The north end of Bute is compoſed of a ſimilar rock with that of Cowal, and the

the fouthern extremity is compofed of the fame rock with the Cumbray iflands, and thefe are of the fame rock with that of the Largs, which is on the fouth bank of the river. Thefe facts would feem to indicate, that the oppofite banks of the Clyde were at one time joined together, forming a very confiderable extent of folid land. If this be admitted, (and there feems little doubt of its truth,) we muft now endeavour to difcover what means were employed to break down the land.

Philofophers in their fpeculations on this fubject, have generally mentioned two agents, which they imagine have produced thefe ftriking and awful phenomena; thefe are the waves of the ocean, and earthquakes. The firft opinion has been ftrenuoufly contended for by the late Dr. Hutton, who affirms, that all bays, peninfulas, iflands, &c. have been formed by the long continued action of the waves of the ocean. This fpeculation at firft fight feems very plaufible, but a more attentive confideration difcovers to us a very exaggerated account of a comparatively partial operation; and this is indeed pretty evident from the following facts. The channel between Italy and Sicily, is nearly the fame to day, as in the time of the Romans. The ifthmus of Corinth has not been vifibly altered for upwards of 2000 years. Scylla, of which Homer has given a correct defcription, is now nearly in the

fame

ſame ſtate as when he wrote *. The ruins of Beritta, the favourite ſeat of Auguſtus, are ſtill to be obſerved in their original ſituation, upon the bank of the ſea, and ſo ſituated, as to be out of the reach of the waves ‡. Ancona built by the Syracuſians, is ſtill by the ſea ſhore †. Here, then, we have inſtances of the land reſiſting the powerful waves of the Mediterranean for upwards of three thouſand years.

Dr. Hutton who was aware of ſome of theſe facts, remarks, that " Our land is waſted by the ſea; and there is alſo a na-
" tural progreſs to be obſerved, which naturally takes place
" on this occaſion; for the coaſt is found variouſly indented,
" that is to ſay, more or leſs, according as the land is expoſed
" to this waſting and wearing operation of the ſea, and accor-
" ding as the waſted land is compoſed of parts reſiſting, with
" different degrees of power, the deſtroying cauſe. The land,
" thus being worn and waſted away, forms here and there
" peninſulas, which are the more durable portions of that
" which had been deſtroyed around; and theſe remaining
" portions are ſtill connected with the mainland, of which
" they at preſent form a part.

" But

* Spallanzani's travells through Sicily, vol. 4. p. 172.

‡ Maundrell's travells from Aleppo to Jeruſalem in 1669, &c.

† Maundrell, ibid.

" But thofe promontories and peninfulas are gradually de-
" tached from the mainland, in thus forming iflands, which
" are but little removed from the land. An example of this
" we have in Anglefey, which is but one degree removed from
" the ftate of being a promontory. Thefe iflands again, in
" being fubdivided, are converted into barren rocks; which
" point out to us the courfe in which the loft or wafted land
" upon the coaft had formerly exifted.

" To be fatisfied of this, let us but look upon the weftern
" coaft of Scotland, from the iflands of St Kilda to Galloway,
" on the one fide, and to Shetland on the other; in this tract,
" we have every teftimony for the truth of the doctrine that
" is confiftent with the nature of the fubject. The progrefs
" of things is too flow to admit of any evidence drawn imme-
" diately from obfervation; but every other proof is at hand;
" every appearance correfponds with the theory; and of every
" ftep in the progrefs, from a continent of high land, to the
" point of a rock funk below the furface of the fea, abundant
" examples may be found. We do not fee the beginning and
" ending of any one ifland, or piece of country; becaufe the
" operation is only accomplifhed in the courfe of time, and the
" experience of man is only in the prefent moment. But man
" has fcience and reafon, in order to underftand what has al-

" ready been from what appears ; and we have but to open
" our eyes and fee all the ftages of the operation, although not
" in one individual object. Now, where the nature of things
" will not admit of having all and every ftep of the progrefs
" to be perceived in one object, an indefinite progreffion in
" the various ftates of different objects, fhowing the feries or
" gradation from a continent to a rock, muft form a proof in
" which no deficiency will be found *."

This is very probably a correct delineation of the mode which nature follows in altering the land, in fome few inftances ; but it cannot be general, as it would give an age to the world quite inconfiftent with the Hebrew chronology ; we muft therefore confider it as untenable. It may be reckoned unphilofophical thus to fhelter ourfelves under the cover of what has been, by fome, confidered a traditional tale ; when facts and reafoning fhould decide the truth of the argument. I am by no means of this opinion, and however unfafhionable it may appear, I am firmly perfuaded, that any chain of reafoning, that does not coincide with that chronology, is falfe. As I have now proved the infufficiency of this theory, I might proceed to confider the other ; yet to prevent the fceptical, from the ufe of any undue argument, I will endeavour to fhow, that allowing Dr. Hutton's obfervations to be correct, they will be

* Theory of the Earth, vol. 2d. p. 265.

be found quite insufficient to explain the breaking of the land of the Clyde, &c. From the account I have already given of the nature of the strata upon both sides of the Clyde, it is evident, that the ocean, in its supposed action, has broken down the hard primary strata, in preference to the softer secondary strata; a fact which strongly indicates the agency of some other power than the sea. Thus we find a considerable portion of the primary strata carried away from the north end of Arran, and Bute, while the secondary and softer strata at the opposite ends of these islands, with the sandstone isles the Cumbrays, stand in the middle of the Firth, defying the rage of the waves. Further, if we look at the map, we will find that all the arms of the sea which are connected with the Clyde, in place of being situated in the secondary strata, upon the south bank of the river, are only in the north side traversing a mountanious country which is entirely composed of hard primitive rock. The great depth of these lochs or arms of the sea is very decisive against Dr. Hutton's explanation. Loch Fyne, at its upper extremity, nearly opposite to Inveraray, is about 60 fathoms deep: Loch Strevin, a small arm of the Clyde, almost inclosed at its entrance by the island of Bute, is yet 38 fathoms deep: Loch Goyle, situated further up the Clyde, is, at its upper extremity, where it is not a mile broad, about 37 fathoms deep: and Loch Long, near its head, is 28

fathoms deep. Thefe lochs are far removed from any violent action of the fea, or of currents; fo that it is impoffible that they could have been formed as Dr. Hutton conjectures, allowing millions of ages for the purpofe.

The other opinion which we have mentioned, viz. "that the land has been often fubmerged and broken by earthquakes," feems to afford us a lefs improbable explanation of the prefent ftate of the Clyde, than that advanced by Dr. Hutton. The frequent occurrence of earthquakes, in the different quarters of the globe, affords us numerous inftances of the fubmergence and breaking of the land: yet we are acquainted with none fo extenfive as that of the Clyde. This, however, is of little importance; as it is not improbable, that thefe cataftrophes were more frequent at a former period, than now. It would extend thefe obfervations to a great length, were I to enter into a detail of all the effects of earthquakes; I fhall therefore only felect a few facts as illuftrative of the prefent opinion. In 1692, when the town of Port-Royal, in Jamaica, was deftroyed by a dreadful earthquake, vaft maffes of land were funk far beneath the level of the fea, and mountains of confiderable extent funk down, leaving in their place extenfive lakes. In 1693, the ifland of Forca difappeared, being fwallowed up by the ocean during a tremenduous earthquake. In 1678, there

was

was a great inundation in Gafcony, caufed by the finking of a part of the Pyrenees: the mountains having difplaced the waters, which exift in the cavities that are contained in the bowels of the earth. In the late moft awful earthquakes that have ravaged Peru, large mountains have been divided into two parts and feparated; others funk down, when large and often bituminous lakes have rifen in their place; and laftly in the earthquakes that devaftated Calabria, there are inftances of mountains finking into the bowels of the earth *.

These facts entitle us to conclude, that at fome former period, this country was convulfed by great earthquakes, when the beds of the Clyde, and its numerous lochs were formed, by the fubmergence of the folid land: at the fame time Arran, Bute, &c. received their infular form, being part of the land that had efcaped the power of the earthquakes. Thefe iflands, as well as the lands on both fides of the river, have, no doubt, fince that period, experienced fome alteration from the long continued action of the weather and the waves of the ocean.

Route

* The earthquake that was felt in Canada, in 1663, overwhelmed a chain of mountains more than three hundred miles long. Clavigero's hiftory of Mexico, p. 321.—Kirwan's Geological Effays, p. 502.

Route from the Iſland of BUTE *to the Iſland of* JURA.

In travelling from the iſland of Bute to the Weſtern Iſles, we have the choice of different tracks, as may be ſeen from the map. That which we purſued, although not the moſt convenient, was yet intereſting, as it allowed us to glance at a conſiderable extent of highland country.

Having examined Bute as much as circumſtances would permit, we croſſed the Kyles to a ſmall houſe called the Kerry, ſituated in the diſtrict of Cowal. In croſſing, we perceived, at a diſtance, ſeveral boats, filled with men dreſſed in black, ſlowly rowing up the ſound. So unexpected an appearance did not fail to attract our attention; and we were told that it was a funeral proceſſion to a burying-place in the adjacent mountains of Cowal. Surely we could have hardly witneſſed a more ſtriking ſcene. Mortality is at all times awful; but it was here preſented to us in a moſt impreſſive manner. The wild and lofty mountains riſing from the ſides of the channel; the almoſt perfect ſtillneſs of the water, which could be faintly heard dying away along the ſhore; the univerſal ſilence, not even diſturbed by the ſcream of ſea-fowl—ſeemed as if nature was unwilling

unwilling to difturb the performance of the laft and melancholy fervices to the dead.

At the Kerry, the fhore is adorned with fweetly-rifing natural wood; fo that we left it with regret, to traverfe a country where grey, rugged mountains, and brown heaths, are the only objects to which our attention could be directed. Having walked for about five miles through a dreary mountainous country, principally compofed of micaceous fhiftus, interfperfed with chlorite, and traverfed with quartz veins; we came to the next ferry-place, which is fituated upon the banks of Loch-Fyne. We croffed from this to Eaft Tarbet, a diftance of about nine miles; and obferved the mountains on both fides of the loch, all the way to Loch-Gilp Head; having the fame general appearance, and being probably compofed of fimilar rocks with Cowal.

Eaft Tarbet is fituated upon the narroweft part of the peninfula of Cantyre; for it is here only about two miles to the fea on the weft fide, which is called Weft Tarbet. There is a tolerable road from the eaft to the weft fide; which is of fome ufe, as this is not only the principal thorough-fare to the iflands of Ifla and Jura, but boats coming from the Weftern Iflands have their cargoes unloaded here, and then are drawn acrofs the

ifthmus,

iſthmus, in preference to the circuitous and dangerous voyage by the Mull of Cantyre. It was once propoſed to cut acroſs this narrow neck of land; but the bad ground at Weſt Tarbet inclined the canal company rather to cut a canal from Crinan to Loch-Gilp Head, through a more conſiderable track of ground, but reckoned more favourable for ſhipping. The canal is now far advanced; but it is very probable that its utility will by no means coincide with the ſanguine expectations that have been raiſed, by the company, and the country in general.

The country, about Eaſt Tarbet, is bleak and rugged. The hills riſe to a conſiderable height; and are compoſed of micaceous ſhiſtus in the lower part, but gneiſs is to be obſerved towards the ſummit, and now and then indurated chlorite is found among the debris. Weſt Tarbet preſents a more pleaſing ſcene, from the natural wood that grows there with conſiderable exuberance.

From Eaſt Tarbet I now continued my journey towards the iſland of Jura, along the banks of Loch-Fyne, which is adorned with natural wood, giving a rich and pictureſque effect to the high cliffs that riſe above the road. The ſtrata are, in general, micaceous ſhiſtus, in ſome places alternating with conſiderable ſtrata of hornblende rock, and traverſed by baſaltic veins: and

I was

I was told that confiderable limeftone quarries were opened among the neighbouring hills, and confequently muft be primitive limeftone. In many places we obferved perfons cutting down the wood, for the purpofe of making charcoal for the ufe of the iron forge near Oban. This is to be regretted; for, in a fhort time, the whole wood will be deftroyed, and the country deprived of one of its greateft ornaments; and merely for the fupply of the working of an iron furnace, that probably might be carried on equally well by a carefully-carbonized peat.

Having walked for feveral miles along the bank of the loch, we now changed our courfe, and croffed through a long, dreary moor, and over hills, when we defcended to the plain at the head of Loch-Kilifled. The rocks are, all the way, of micaceous fhiftus, which is, in many places, quite difintegrated, the loofe mica forming banks feveral feet thick. This mica, if free from iron, might be of confiderable value; as we find Mr. Wedgewood ufing the fine white mica of Cornwall for the manufacture of porcelain and his very ufeful pyrometers ‡. It is therefore worthy the attention of the proprietors to examine the neighbouring country, where probably confiderable quarries of colourlefs

‡ Journal des Mines, No. 3. p. 119.

mica might be found. At the head of Loch-Kilifled I obferved a confiderable ftratum of blue-coloured, granularly-foliated limeftone, ftratified with micaceous fhiftus. The micaceous fhiftus is here frequently mixed with felfpar, forming a fpecies of gneifs difficultly diftinguifhable from fandftone.

After leaving this plain, we had a difficult afcent for a confiderable way, but the tedioufnefs of the track was a little relieved by the natural wood through which we paffed; this, alfo, foon difappeared, when brown moffes, and grey, bleak hills, were again characteriftic of the country. Having walked for feveral miles through this dreary and defert fpot, we were fuddenly ftopped upon the brow of a hill, from which we had a view of the grey, fteril mountains of the mainland, rifing into various rugged forms, and intermixed with lochs, thus prefenting a wild and defolate fcene. Soon afterwards, we came in fight of the rugged ifland of Jura, the ifland of Ifla, and, farther diftant, the mountains of Mull. Thefe we viewed with much pleafure, as they were foon to be objects of our particular attention. We now defcended from the mountains to the fea-fhore; where we obferved an old, gloomy, ruinous building, called Caftle Swein, fituated in a wretched-looking country. Even the few inhabitants we faw, had fomething fo melancholy and depreffed in their appearance; their miferable huts were in fuch unifon with

with the ſcenery—as to occaſion in us an unuſual lowneſs of ſpirits. We haſtened, therefore, from this ſpot, and croſſed a ſmall ferry, and then walked about three miles to the ſhore oppoſite the iſland of Jura. The ſtrata, all the way from Kiliſled to this place, ſeem to be principally micaceous ſhiſtus, frequently paſſing to talcaceous ſhiſtus.

We here were fortunate in getting a boat, in which we paſſed to the iſland of Jura.

We now examined a part of this iſland, and then croſſed to Iſla, where we remained a few days; and again returned to Jura, previous to our voyage to the Slate Iſlands. As it would be irregular, and little ſatisfactory, to detail the obſervations in the exact order in which they were made, I prefer firſt giving an account of Iſla, and then of Jura.

ISLA AND JURA.

CHAP. X.

Abstract of the Mineralogy of the Islands Isla *and* Jura.

ISLA.

THIS island is thirty-two miles long, and, in some places, nearly as broad. It is the most southern of the Æbudæ, or Hebrides; and its name is traditionally derived from Isla, the daughter of one of the kings of Lochlin, or Norway, who was buried in the parish of Kildalton. Dr. Campbell, in his Political Survey of Great Britain, remarks that it is the Epidium Insula of Ptolemy; and he imagines (erroneously, however) that it is denominated Isla, or The Isle, as being the seat of government when the Western Isles were ruled by the princes of the Isles.

It

It approaches fomewhat to a fquare fhape, and is much interfected by the fea, in particular by two confiderable lochs, one on the weft fide, called Loch Graynard, the other upon the fouthern extremity, called Loch-in-daal. It is bounded upon the N. E. by the rugged and fteril ifland of Jura; on the E. by the ifthmus of Cantyre; towards the S. it is feparated only about 20 miles from Ireland; but on the W. it is expofed to all the violence of the Atlantic Ocean.

The cliffs around the coafts of the ifland are, in fome places, of confiderable height, particularly at Macarthur's Head, where they rife with great grandeur and magnificence. The fhores are often covered with immenfe maffes which have fallen from the neighbouring cliffs; but, in other quarters, the cliffs difappear, when we have fhores bounded by confiderable fandy beaches. Beds of cailloux roulés, or boulder ftones, are to be obferved upon the fhore, but placed a confiderable diftance above high-water mark; and in the fpace of ground between the two lochs juft mentioned, there is an extenfive links, or down, where we find, under the thin covering of grafs, fand, boulder ftones, and fhells. Thefe appearances, which are proofs of the retiring of the fea from the land, are to be feen in many parts of the Weftern Iflands.

This

This iſland, when compared with many of the Hebrides, is low; none of the hills being above 1700 feet above the level of the ſea. The low grounds are pretty flat, often well ſheltered; and, through the exertions of the preſent proprietor, Walter Campbell, Eſq, of Shawfield, improvements are carried on with ſpirit: the moſs lands are daily rendered arable: thus beautifying the iſland, and rendering it the moſt productive of the Hebrides, its yearly rent being now about 10,000 l. *

Mineralogy. To render the few obſervations I have to make on the mineralogy of this iſland diſtinct and ſatisfactory, I will firſt deſcribe that ſpecies of rock which forms the interior, with its accompanying veins, and then trace the other ſtrata around the coaſts of the iſland.

Mining Field. The interior, or middle part of the iſland, from its containing a great number of metallic veins, and being the ſeat of all the workings, may be called the Mining Field. It

* On the forfeiture of the Macdonalds, Iſla, Jura and the lands of Muckrain were given to Campbell of Calder, upon condition that he would pay 500 l. of yearly feu-duty out of Iſla. Campbell, about fifty years ago, ſold theſe lands to the Shawfield family for 12,000 l. which is now their yearly rent: a moſt ſtriking example of what may be done by ſpirited improvements.

It is entirely compofed of blue-coloured limeftone, which is fuppofed to occupy about thirty-fix fquare miles; extending in diftance (fo far as I could obferve) to the fea-fhore; neither does it rife to any confiderable height, for other rocks generally take its place when it rifes to a few feet above the level of the fea. The limeftone ftrata dip towards the S. W. Numerous fymptoms of galena occur in this limeftone, and feveral veins have been worked with confiderable advantage. The principal feat of thefe workings feems to have been in the neighbourhood of Garthsnefs, which is fituated about the middle of the limeftone diftrict. At this place there are the remains of a lead vein, which runs S. E. and N. W. and dips towards the S. Befides the galena, there alfo occurred, in the working, rich copper pyrites; and it is faid that, at one time, fpecimens of fulphurated manganefe had been difcovered. At Glafgow-beg there is another vein of galena, running E. S. E. and W. N. W.; but it is traverfed by a bafaltic vein, which runs nearly S. S. W. and N. N. E. At a little diftance fouthward from this, we obferve an open caft vein, which runs E. and W. and dips to the S.: it is alfo croffed by a bafaltic vein, as that at Glafgow-beg: the bafaltic vein is about nine feet wide, and has thrown the lead vein about three feet from its original direction. There are many other mineral appearances befides thefe now mentioned; but it would extend thefe notes too far to fpecify more of them.

Many

Many other bafaltic veins are alfo to be feen: fome traverfe the metallic veins; others crofs each other: in fhort, a plan of this mining field would reprefent a limeftone diftrict divided into a number of angular and fquare fragments.

The bafaltic veins are of various fizes, from one to twelve feet in width. Many of them run parallel to each other; fome run in a crofs direction, marking, according to the manner in which they interfect, their relative antiquity †; and not unoften thefe veins ftand up like artificial walls, owing to the limeftone being more eafily acted upon by the weather, and being confequently firft carried away.

Befides the galena, confiderable quantities of copper pyrites have been found, but the quantity too fmall to be of any confequence. Alfo, upon the fouth fide of the limeftone diftrict, near to Loffit hill, iron ore has been quarried; but its fituation is not yet well afcertained; and I am afraid, from the accounts I have heard, that it will be trifling. The workings in thefe veins have never afforded fluor fpar; they produce only barytes and calcareous fpar. Fluor fpar is a rare production in Scotland:

† Werner Neue Theorie von der Entstehung der Gange.

Scotland: I have only obferved it twice; once in Shetland, as will be mentioned afterwards; and in a vein among the granite mountains of Aberdeenfhire.

Before concluding this fhort defcription of the mining field, I fhall mention two remarkable facts, which feem well authenticated.

1. *Silver.* It is confidently affirmed that a lump of capillary filver, weighing fixteen ounces, was found with the galena, in the vein at Garthsnefs. This is an interefting fact; and, fhould the veins be again opened, will prove a frefh incentive to carry on the working with fpirit, as it is not improbable that veins of filver may be found. We know that fcarcely three years have elapfed fince native filver was difcovered in Great Britain, and it is of confequence to obferve, that it occurred in a fituation fomewhat analogous to that in Ifla, the filver forming a ftring, branching from the fide of a vein of galena †.

2. *Quickfilver.* A quantity of this valuable metal was difcovered in a peat mofs fome years ago; and Dr Rotheram informs me that it is now in the poffeffion of Mr Campbell. Some flight fearch has

† It was at Hurland, in Cornwall, where this filver was difcovered.

been made to difcover its fituation, but without fuccefs. This muft not, however, be confidered as a proof that no veins exift; for, to determine this, it will require a more regular mode of inveftigation than has yet been purfued. Farther, the following facts fhow that limeftone rocks are not unfavourable to the production of quickfilver: 1. It is found in globules, in white limeftone, at Marfala, in Sicily; (*Mineralogie Sicilienne*, par Borch, Turin 1780.) 2. Behind Guancavelica, in South America, the ardefia paffes into limeftone, which is rich in filver and mercury; (Helm *Tagebuch reifen durch Peru*, p. 431.) In the mineralogical collection at Paris there are fpecimens of limeftone, brought from the neighbourhood of Grenoble, which contain quickfilver *.

Obfervations. The mineral treafures of this ifland, from their being fituated fo near the furface, muft have early attracted the notice of the inhabitants; particularly as the Norwegians, the former mafters of the ifland, were early celebrated as miners. We do not, however, find any mention of thefe mines, until the time of Boethius ‡, who wrote 300 years ago; but

* Journal des Mines de la Republique Francoife, No. 1. p. 77.

‡ Boethius Scotor. Reg. Defcript.

but even at that period they feem to have been of much confideration, for he remarks, " cum frumenti ferax, tum metallorum dives." Since that period they have paffed through many hands; but do not appear, in any of them, to have been conducted with all the judgement neceffary for fo difficult and important a bufinefs. It is a matter of much regret that thefe mineral appearances, as well as many others, equally interefting, in different parts of Scotland, have not been profecuted with more advantage. Many circumftances have contributed to this want of fuccefs; but, we apprehend, the principal one is to be found in the ignorance of the generality of miners, who are too often men of little education, and obftinately wedded to their own foolifh practices. Even in Cornwall, where the mining bufinefs fhould be beft underftood, we obferve them often working in an expenfive manner. In Scotland particularly, wanderers from other countries, not regularly bred in the principles and practice of mining, have often impofed upon landed proprietors, by holding out to them flattering profpects of great gain, and have thus thrown a temporary obftacle in the way of improvement. It is to be hoped that the increafing tafte for chemical and mineralogical ftudies will enable proprietors to treat fuch pernicious pretenders with that contempt they fo juftly deferve.

U 2 Having

Having defcribed the mining field, I fhall now proceed to examine the rocks around the fhores of the Ifland; and to do this with regularity, will begin at Portaskeg, a fmall harbour fituated upon the found of Ifla. Here the cliffs are low, and compofed of compact micaceous fhiftus; which paffes either to Ardefia, or Gneifs; and in all thefe gradations, are to be obferved, rounded or irregular fhaped pieces of granite. This granite, which is compofed of red-coloured felfpar, and white quartz, and fometimes iron pyrites, cannot be faid to be connected by a pafte in the manner of a breccia, as the granitic maffes and fhiftus pafs into each other, fhowing that they have been formed at the fame time. Ferber *, who has obferved fimilar appearances in the mountains of Ruffia, agrees with Pallas †, in fuppofing that gneifs, micaceous fhiftus, and ardefia, are formed from the detritus of granite mountains; and upon this theory, he explains the appearances we are now confidering. He conjectures, that the groffer particles of granite, having undergone a little alteration, are agglutinated in the form of granite, and inclofed by an aggregation of the fmaller parts, which become argillified, forming the ardefia. This explanation is untenable, and unneceffary, when we con-

fider

* New Tranfactions of the Imperial Academy of Peterfburg, vol. II.

† Obfervations fur les Montagnes, 4to. Peterfburgh.

fider that after the greater part of the granite was precipitated, ftill a fmall quantity might remain, which would be depofi-ted along with the ardefia, and form thin ftrata inclofed in it ‡, or irregular fhaped difperfed pieces, as in the cafe at Port-afkeg.

From Portafkeg the coaft becomes gradually higher as we approach Macarthur's-head, and is formed for a confiderable way of rocks fimilar to thofe I have juft mentioned, which the fea has in fome places hollowed out into confiderable caves. As we approach nearer to this great head-land, the cliffs become much higher, and the micaceous fhiftus, &c. dif-appears; a granulated quartz taking its place *. Immediately upon the fhore, I obferved a large bafaltic vein traverfing the granulated quartz, rifing up through it like an immenfe wall, and

‡ Karften 3 Helvet. Mag. and Monnet 25 J. Phyfique, 85.

* Mr Mills, in his account of fome ftrata in Ireland and Scotland, detailed in the Philofophical tranfactions of the Royal Society of London, for 1790, has given a defcription of Ifla. As it differs confiderably from the obfervations I am now to detail, it will be neceffary as I proceed, to contraft our obfervations; fo that future travellers, may be enabled to judge, who is in the right. Speaking of this part of the ifland, he fays, " that it is compofed of chert, which extends to Macarthur's-head.

and extending along the ſhore to a conſiderable diſtance ; in ſome places forming a powerful barrier between the ſea and a few cottages, which are built at the bottom of the cliffs. Having reached the head-land, I obſerved the cliffs riſing to a great height, and compoſed of ſtrata of arenaceous quartz, elevated at an angle of 45° ; and the rocks being tinged of a red colour, give a very wild character to the ſcene. This arenaceous quartz extends to a conſiderable diſtance ; but is at length interrupted by a rock, which has much the appearance of a breccia, being compoſed of variouſly ſhaped pieces, (and ſome of great ſize) of the granulated quartz, connected by ſmaller particles of the ſame quartz ; which has intermixed mica, and talc *. Frequently the whole has a red colour, which is owing either to the decompoſition of the mica, or ſulphuret of iron, which is ſometimes diſperſed through it. As we wandered along the ſhore, I obſerved this breccia interrupted by a vertical ſtratum of micaceous ſhiſtus : upon one ſide of the ſtratum, is the breccia ; on the other, is the diſtinct granulated quartz. I would recommend this appearance to the particular attention

* Dr Townſon in his travels among the Carpathian Alps, obſerved great ſtrata of granulated quartz, (what he calls primitive ſandſtone) lying upon granite, and he obſerved it in all the ſtates from fine granulated quartz to that of breccia, as in the caſe with the rock of Iſla.—Travels through Hungary, 4to.

tion of future travellers, for I muſt confeſs, I was ſo fatigued when I reached this ſpot, that I could not give it that attention it undoubtedly deſerves. The granulated quartz now forms cliffs along the ſhore, until we come to a ſmall bay, where ſtrata of micaceous ſhiſtus appear; and here the hills riſe to a conſiderable height, being compoſed of micaceous ſhiſtus upon the lower part, and towards the ſummit, probably of granulated quartz. We now croſſed over ſome higher grounds until we reached Ben-vinkie, which is ſaid to be the higheſt hill in the iſland, although it is not more than 1700 feet above the level of the ſea. The lower region of this hill is compoſed of micaceous ſhiſtus; but as we go upwards, granulated quartz makes its appearance; and upon the ſouth-weſt ſide, which is very ſteep, a great vein of baſalt reaches very nearly to the ſummit. The country becomes lower after paſſing this hill, and is pleaſantly diverſified with ſmall irregular hills, that are intermixed with natural wood. The cliffs upon the ſhore are not very high, but are much broken by the action of the ſea, which has formed many detached rocks; and theſe, having a grey colour, preſent a ſtriking picture of ſterility. Along with the micaceous ſhiſtus, we have now ſtrata of ardeſia, chlorite-ſlate, hornblende rock *; and

theſe

* Theſe Mr Mill includes under the name of Hornſtone.

thefe continue to Loch-Kuneftle, a fmall harbour on the coaft. At this harbour, we obferved a low hill called Knock Kuneftle, which is compofed of ardefia, chlorite-flate, &c. in its lower part; but upon the fummit, decompofing greenftone makes its appearance. I could not determine whether it forms a ftratum or a vein; but obferved, that when in a ftate of decompofition, it affected the compafs at the diftance of four feet. From this to Lugwillan, the coaft and country continue rugged, and compofed of the fame rocks as thofe which extend from Macarthur's-head to Loch-Kuneftle. This little village, unluckily for the traveller, is extremely wretched; prefenting a fad picture, if not of poverty, yet of dirtinefs and floth. It would certainly be much for the advantage of the proprietors, as well as conducive to the comfort of the peafantry, if commodious houfes were built, and ftrict regulations with regard to cleanlinefs enjoined. I mention with pleafure, that Mr Campbell, has already in part begun this meritorious plan, and it is not to be doubted that he will foon feel the advantages of it.

After leaving Lugwillan, we met with a fmall harbour named Leodamis, or Lowdinas bay, which affords fhelter to fmall veffels; but like other harbours upon this coaft, it is dangerous from the number of funk rocks, which extend to a confiderable diftance. The rocks in this neighbourhood are compofed

posed of micaceous shistus, which by its decomposition forms a fine white sand, that covers the shore; and at the upper extremity of the harbour, I observed several pieces of melanteria, or black chalk, which seemed to have been detached from strata that probably alternate with the micaceous shistus. We now walked for ten miles, through a level country, to Loch-laggan, a sinuosity upon the side of Loch-in-daal. The rocks in this tract, are composed of micaceous shistus, and the general appearance of the country, to the extremity of the island, where it is terminated by the lofty Mull of Kinhouth, announce a similarity of composition. From Loch-in-daal to the village of Bowmore, we passed thro' a level country, formed principally of micaceous shistus *, which appears, in some places, to alternate with greenstone. This last mentioned fossil, as also wacken, have been observed, in other countries, in a similar situation; but basalt, as Dr Mitchell informs me, is peculiar to the flotzgeburge, or stratified mountains. We are, therefore, to consider the observations of the celebrated Charpentier ‡ and

X Faujas

* Mr Mills remarks, that the whole extent to Kenhouth-head, and so on to Bowmore, is hornstone.

‡ 4 Helvet. Mag. 445. 546. Ibid. 3. 236. Charpentier, 81, 187.

Faujas St. Fond †, who affert that bafalt ftrata occur in primitive mountains, as indicating only greenftone or wacken.—The village of Bowmore, which is the principal one in the ifland, is pleafantly fituated upon the banks of the loch, and is the centre of all the bufinefs in the country. From this to Kiliru the roads lead through a flat country, part of which feems to have been gained from the fea. Near Kiliru is the feat of Mr. Campbell, which is pleafantly fituated at the head of the loch, but is much expofed, from the want of planting. From Kiliru to the point of Runs, the ifland is in general low, excepting about the Runs, where it rifes into hills, of which Bentarvil is the higheft. Being difappointed in examining that part of the ifland, we croffed from Kiliru to Kilchoman. The country, in this direction, is low, interfperfed with fmall lochs, and in fome places well cultivated; and micaceous fhiftus, traverfed with quartz veins, is the only rock that occurs. Near to Kilchoman, I obferved an old, ruinous, gloomy building, which was once the feat of the turbulent Macdonald, prince of the Ifles, but is now peacefully inhabited by the minifter of the parifh. From Kilchoman to the fea-coaft, the country is low; and the rocks, which extend along the fhore, continue to form low, broken cliffs of micaceous fhiftus, alternating

† Faujas fur le Trap, p. 86.

ternating with ſand banks, until we come to Saneg-more. Here the cliffs riſe to a conſiderable height: and, being much expoſed to the ocean, are broken into many fantaſtic forms, preſenting a grand and romantic piece of ſcenery. Knowing, from Mr. Pennant *, that there was a fine cave in theſe cliffs, we wiſhed to examine it. Accordingly, having procured guides, through the goodneſs of Mr. Campbell of Sanicks, we deſcended a ſteep precipice to its entrance, when we found ourſelves ſurrounded by lofty, rugged precipices, which towered far above us. The grandeur of the ſcene was much heightened by the turbulence of the ſea, which came rolling in ſlowly, but with awful majeſty, daſhing among the rocks, with a noiſe that reſounded on all ſides like the diſcharge of artillery. Having entered the cave, we found it pretty extenſive, but damp and black, owing to the water falling from above. At a little diſtance, the guides directed us into a narrow opening on one ſide, into which we ſcrambled with ſome difficulty, but found only a dark, dreary cavity, of little extent. As we walked onwards, the cave became larger; but we were ſoon ſtopped by a pool of water, which appeared to be pretty deep. The guides croſſed through it, and walked to the further extremity of the cave; and the effect produced by the retiring of the lights,

X 2 was

* Voyage to the Hebrides.

was not the leaſt intereſting part of this ſcene. Formerly, when the cave was dry, the gentlemen of the country uſed to illuminate this wild grotto, and collect all the beauty of the iſle to dance to the bagpipe.

We now left the cave; and, in our aſcent, obſerved ſeveral baſaltic veins traverſing the micaceous ſhiſtus. From this to the mouth of Loch-Grynard, is an alternation of ſandy beaches and low cliffs of micaceous ſhiſtus and ardeſia, in ſome places traverſed with baſaltic veins, of various ſizes, from a few feet to nearly forty feet wide. Theſe appearances are ſo numerous, that I could not poſſibly afford time to examine them all minutely; ſo that it will not be ſurpriſing that after travellers ſhould find, in ſome places, ſtrata inſtead of veins. Loch-Grynard is of conſiderable extent; is uſually bounded by ſandy banks, but ſometimes low rocks of micaceous ſhiſtus appear; and at its head are the links or downs we have already mentioned, which extend nearly to Loch-in-daal. From this loch to the great caves which are ſituated upon the north-weſt part of the iſland, the ſhore is, as uſual, an alternation of low, rugged cliffs of micaceous ſhiſtus and ſandy beaches; but, as we come nearer to the caves, the cliffs are much higher, and, in place of micaceous ſhiſtus, we have rugged precipices of granular quartz. We deſcended a path made in theſe

cliffs,

I Grant sculp.t

VIEW of the GREAT CAVE of ISLA looking outwards.

cliffs, which brought us among rocks terribly broken by the fea; and after walking a few hundred feet, the caves prefented themfelves with much dignity. The height of the rocks in which they are fituated; the wild and rugged grandeur of the neighbouring hills; the folitude of the place; all add frefh intereft to this ftriking fcene. The great cave, or what is called, in the Erfe language, Ea-maur, is about thirty-three yards wide at its entrance, and from fix to eight yards high: as we go inwards, the roof becomes higher, but it foon again contracts in all its dimenfions; and about 150 yards from its entrance, it is fo narrow and low, as to prevent any one from getting farther. It is fituated in granular quartz, as is the cafe with the other fmaller caves. The celebrated Sauffure has lately publifhed a feries of experiments upon the temperature of caves, in which he obtained fome curious refults. I repeated them carefully in the great cave, but did not find a difference of more than 8° of Fahrenheit between the temperature of the cave and that of the fhade.

At a little diftance from the caves, I obferved the granular quartz covering a fpecies of fhiftofe talc, and alfo, a fpecies of marl, in the neighbourhood of the granular quartz and micaceous fhiftus: but I had not an opportunity of examining their relative pofition.

* Mr Mills remarks that the caves are in rocks of chert.

poſition. From this we croſſed a very fatiguing moor to Portaskeg: the rocks, all the way, are of granular quartz, (extending even to the ſummit of the higheſt hills,) excepting a few places upon the ſea ſhore, where micaceous ſhiſtus appears.

JURA.

THIS iſland is about 32 miles long, and 6 broad; but at Tarbet it is nearly divided, being only a mile and a half broad. It is bounded on the E. by Knapdale and Cantire; on the S. by the iſland of Iſla; upon the W. by Colonſay, Oranſay, Mull, &c.; and towards the N. the Slate iſlands. It is in general very mountainous, particularly upon the S. W. extremity, where are ſituated the high hills called the Paps of Jura. None of the Hebrides preſent ſuch a maſs of rugged barrenneſs. The hills are often grey and bare; and the ſcanty portions of the lower ground which are cultivated, ſeem ill managed. The ſhore upon the eaſt ſide is in general low; but upon the weſt it riſes frequently to a great height, and is broken into many ſtriking forms; particularly we obſerve extenſive caves, which afford ſhelter

Engraved by R. Scott Edin^{r}.

CAVES on the WEST COAST of the ISLAND of JURA.

ſhelter to the deer and goats that browze among the neighbouring rocks.

Mineralogy. The mineralogy of this iſland, as far as I examined it, is but little intereſting, as it does not differ materially from that of the ſhores of Iſla. I ſhall not omit, however, to give a ſhort account of it, as its mineralogy has not engaged the attention of any writer.

Immediately below Ardſin, the ſeat of the hoſpitable Archibald Campbell, Eſq. I obſerved ſtrata of granular quartz, inclined at an angle of 45°; yet they are not regularly ſo, for I obſerved them inclined at different angles in other parts of the iſland. This rock forms the coaſt of the iſland all along the ſound of Iſla, and, as far as I could obſerve, it appears to extend along the whole weſt coaſt. The cliffs are, in ſome places, of conſiderable height; and the great maſſes which are ſeparated from them have, in general, a tendency to the pyramidal ſhape. This is another fact, ſimilar to what I obſerved in Arran, ſhowing that particular rocks break in ſuch a manner as to be characteriſtic of their peculiar nature. Theſe quartzy maſſes, by further decompoſition, fall into ſmall cryſtalline grains, which cover the ſhore, in ſome places, to a conſiderable

extent;

extent; and form a ſand, which is aſſuredly among the pureſt that nature affords. It has been uſed with much ſucceſs in the making of fine glaſs; and I have little heſitation in ſaying, that it is worthy of being more generally known as an article for glaſs-making: indeed it might alſo be advantageouſly uſed for the making of ſmalt, and different kinds of porcelain, in the place of powdered quartz, or flint.

Many baſaltic veins are to be ſeen traverſing theſe quartzy ſtrata, which extend along the ſound of Iſla and the weſt coaſt of the iſland: and it is curious to obſerve the manner in which theſe two rocks decompoſe; for upon this circumſtance depends the varied appearance of the rocky ſcenery on the weſt coaſt of Jura. Sometimes the baſalt decays firſt, leaving only the empty ſpace which the vein had formerly filled; and this afterwards is much enlarged by the decaying of the quartz: thus forming caves ſuch as are repreſented in the plate. In other inſtances, the granular quartz decays firſt; and either falls away from the ſide of the baſaltic vein, or is waſhed away by the ſea: thus leaving the baſaltic rocks extending acroſs the beach like immenſe walls. Theſe great maſſes of baſalt are often broken into various ſhapes; but the

Engraved by R. Scott Edin

A View of a PERFORATED BASALTIC VEIN. N.W. coast of the ISLAND OF JURA.

the moſt ſtriking appearances are formed by the central part of the vein decaying firſt, which leave magnificent arches: but the engravings of this coaſt will convey a more lively idea of the character of theſe rocks, and the general appearance of the ſcenery, than any deſcription.

There are many caves upon this coaſt, and ſome of them of vaſt ſize; but my time did not allow me to viſit the moſt remarkable.—In wandering among the rocks, I obſerved ſeveral banks of coral ſand; which I was happy at obſerving, as it will be of great uſe to this iſland, heretofore deſtitute of all kinds of calcareous matter, and abounding with much improvable peat moſs.

Paps of Jura. Theſe mountains, which are the moſt elevated in the iſland, are diſtinguiſhed by different names. The three moſt remarkable are, Beinn-a-chaolois, or, the Mountain of the Sound; Beinn-ſheunta, or, the Hallowed Mountain; and Beinn-an-oir, or, the Mountain of Gold. The laſt mountain is the higheſt; being about 2600 feet above the level of the ſea; and is, like the others, ſomewhat of a conical ſhape.

We clambered to the ſummit of one of theſe hills, but found the aſcent very ſteep, and fatiguing, from the number of ſmall looſe ſtones that cover its ſides: but our fatigues were

ſoon forgot in the immenſity and variety of the proſpect now before us. Immediately below was the rugged ſcene of the grey, ſtorm-beaten rocks of Jura, interſperſed with numerous lakes; conveying, as Mr Gilpin remarks, the idea of complete ſterility. To the S. the iſland of Iſla ſeemed ſpread under our feet; and, farther diſtant, appeared the coaſt of Ireland. To the W. we obſerved the ſmall iſles of Gigha and Cara, the iſthmus of Cantyre, and the lofty red-coloured granite mountains of Arran, forming a ſtriking contraſt to the ſombre hue of the mountains of Cantyre; and, ſtill at a great diſtance, our view was bounded by the diſtant county of Ayrſhire. On the N. E. we obſerved the wild alpine ridges of Argyleſhire, extending all the way to Ben-Lomond. To the W. the Hebrides appear, ſcattered through the ocean: the iſles of Colonſay and Oranſay are in our immediate neighbourhood; farther diſtant, is the mountainous iſland of Mull, the celebrated I-colm-kill, with the adjacent iſles; and the long-extended iſles of Coll and Tirie appear like a haze in the horizon.

Theſe mountains are principally compoſed of ſtrata of a granular quartz, elevated at an angle of 45°, and dipping to the ſouth-weſt. From the ſummit of the hill, the ſtrata appear to run in different directions; ſome curved, and others nearly horizontal: theſe appearances, however, are probably more owing

owing to the ſituation from which I viewed them, and the ends of the ſtrata being worn down by the rain, &c. than to any alteration in their dip or direction. The fragments of rock which cover the ſides and tops of theſe mountains, are broken into ſmall angular fragments; which, obſerved at a diſtance, and even with a teleſcope, would ſhow us, that they are formed of a rock very different from granite; as the latter almoſt always decompoſes in large rhomboidal maſſes.

I frequently obſerved maſſes of this granular rock; which, from its containing felſpar and mica, is to be conſidered as a true granite. This fact, will be reckoned, by certain geologiſts, as deciſive againſt the opinion of Mr Werner; who affirms, that granite is the oldeſt rock, and conſequently, that upon which the others reſt. It cannot be denied, that there are ſeveral facts, detailed by the moſt intelligent geologiſts, which ſhow, that granite is ſometimes of a cotemperaneous formation with ardeſia *, micaceous ſhiſtus †, and gneiſs ‡; yet they are ſo rare, that I can only conclude from them, as I have before mentioned, that after the greater part of the granite

* Reuſs Mineralogiſche Geographie von Bohmen, B. 2. 180.

† Journal de Phyſique. New ſeries, vol. 1.

‡ Emmerling's Mineralogie, B. 3.

nite had been precipitated, ſtill a ſmall portion remained in ſolution; and was afterwards depoſited along with the gneiſs, or other primary rocks. The opinion of Mr Werner, on the other hand, is ſupported by ſo vaſt a maſs of evidence, as bears down all oppoſition. Thus, according to Sauſſure, the granite of the Alps, excepting in one or two inſtances, is always covered with other ſtrata; itſelf forming the interior, and often the higheſt parts of the mountains. The ſame obſervation has been made by Baron Born, and Eſmark in the mountains of Hungary and Wallachia; by Palaſſo, La Peyrouſe, and Carbonieres in the Pyrenees; by Reuſs in the mountains of Bohemia; Lazius in thoſe of the Hartz; by Patrin, Herman, Pallas in the vaſt extended empire of Ruſſia; by the French mineralogiſts in all the granite mountains of France; alſo in the granite mountains of the Weſt Indies, and in the few which have been examined in England † and Scotland.

Having mentioned the different kinds of rock which form the coaſt and hills, from Ardfin, along the ſouth and weſt parts of the iſland. We will now proceed along the eaſtern ſhore.

† In the great mine in Cornwall, called the Cooks Kitchen, I have been told, that the granite has been found above the ardeſia (or killas). I have not as yet had it accurately confirmed.

ſhore, from the ſame place. Upon the ſhore, at a little diſtance from Ardfin, ſtrata of micaceous ſhiſtus, alternating with rocks intermediate between talcaceous ſhiſtus and ardeſia, appear, and continue forming low cliffs along the ſhore to the harbour of the ſmall iſles *. Theſe rocks are ſometimes very compact, and have a tendency to break into irregular columns; ſo that in ſome points of view, they are not unlike columnar baſalt: we alſo obſerved baſaltic veins traverſing them in many places. From this the country gradually riſes as we approach the high hills, the paps of Jura; and in ſome places, as upon the road leading from Ardfin to Small Iſles, chlorite-ſlate is to be obſerved alternating with the other rocks. This chlorite-ſlate, ſometimes paſſes to hornblende rock, by a mixture of green hornblende; and it ſometimes contains calcareous ſpar, and cryſtals of yellowiſh-green actynolite diſperſed; but this latter is a rare appearance. Not unoften I obſerved the chlorite penetrating the quartz, forming a dark green coloured ſtone; and here I was ſo fortunate as to diſcover that rare foſſil, the cryſtalized chlorite, of which a particular deſcription is given in the following chapter. If we ſtill continue our courſe towards the high hills, we at

* About a mile diſtant from Ardfin, we landed upon a ſmall low iſland, which is compoſed in general of a coarſe talcaceous ſhiſtus; and between the ſtrata we obſerved layers of beautiful hornſtone.

at length find the granular quartz rifing from under the micaceous fhiftus, at an angle of 45°, and from this, the whole country to the fummit of the mountains is formed of the fame rock.

We would naturally conclude, from finding the quartz ftrata lowermoft, that it had been depofited before the micaceous fhiftus; this is only true in part, as we fometimes obferve the micaceous fhiftus paffing to granular quartz, at a great diftance from the junction †.

As far as my experience goes, mountains of granular quartz are to be confidered as rare occurrences in Scotland: in Caithnefs, I obferved quartz mountains, as will afterwards be mentioned: and Mr Williams tells us of quartz mountains in Rofs-fhire *: but thefe are the only inftances I am acquainted with. It is even an unfrequent rock in other countries; in the Carpathian Alps, Dr. Townfon informs us, he obferved what he calls primitive fandftone lying upon granite; and Mr Deriabin, to whom I fhowed the Jura rock, affures me that it is fimilar

† In Brainfdorf, in Saxony, granular quartz has been obferved paffing into micaceous fhiftus. 2. Crell. Beytr. 64.

* Williams's Mineral Kingdom, vol. 2. p. 52.

ſimilar to that which forms ſo great a portion of theſe mountains.

As the diſcovery of limeſtone would be of much ſervice in the agricultural operations of this iſland, we were anxious to aſcertain if any ſuch ſtrata exiſted between the Small Iſles and the Sound of Iſla. To determine this, we examined not only the ſhores, but the ravines upon the ſides of the hills, yet without ſucceſs. This failure in our reſearches does by no means imply that limeſtone does not exiſt in this diſtrict, particularly when we recollect that theſe rocks are not unfavourable to it. We have many inſtances of limeſtone being found in micaceous ſhiſtus, in different parts of Scotland, as at Dalmally, near Blair in Athol, &c. ‡ It may even occur in granular quartz; as Eſcher has obſerved limeſtone among granular quartz in the valley of Reuſs.—Townſon upon the granulated quartz (primitive ſandſtone) of the Carpathian Alps, &c.

The harbour of the Small Iſles is rendered pretty ſafe by three

‡ Werner has obſerved limeſtone alternating with micaceous ſhiſtus and ardeſia, in Saxony: ſo has Charpentier, and that in great ſtrata. Werner, Kurze Claſſific. 14. Charpent. 55, 56, 57, 174, 201, 400.

three or four ſmall iſlands, that defend it from the violence of the ſea. It will admit veſſels of ſeveral hundred tons; yet, as the iſland and the neighbouring country are but thinly inhabited, few veſſels are to be ſeen enlivening this ſolitary ſcene. The country in the neighbourhood riſes gradually as it approaches the Paps of Jura, which here preſent a magnificent and ſtriking mountainous ſcene. The ſtrata, from the ſhore to the vicinity of the Paps of Jura, are compoſed of micaceous ſhiſtus; excepting at one place, about half a mile north from Mr Macnicol's houſe, where we obſerved a ſtratum of ardeſia tegularis (roof ſlate) cropping through the heath. This ſtratum, which appears to be of conſiderable breadth, is bounded by the micaceous ſhiſtus; and, near the junction, the micaceous ſhiſtus contains cubical cryſtals of iron pyrites *.

From the Small Iſles to Luggan, the ſtrata of micaceous ſhiſtus ſtill continue, often very compact, and frequently traverſed by baſaltic veins. At Tarbet, which is the narroweſt part of the iſland, the land immediately upon the ſhore is low; and the eye is refreſhed by the appearance of a beautiful

* May not the preſence of cubical pyrites, in micaceous ſhiſtus, be indicative of the vicinity of ardeſia tegularis?

tiful green flat, at the bottom of the grey hills which bound the ſhore. From this to Kenawochrach, the northern extremity of the iſland, micaceous ſhiſtus appears to be the general rock, but it is ſometimes alternated with ardeſia tegularis. At one place the ardeſia has been quarried; and, from what we could learn, there can be little doubt that, with well-directed experience, the working may become of conſequence.

CHAP. XI.

Deſcription of the FOSSILS *mentioned in the preceding Chapter.*

GRANULAR QUARTZ.

CYAMEA, Dr Walker's Claſſes Foſſilium. *PRIMITIVE SANDSTONE*, Mr Kirwan's Geological Eſſays, p. 208. *QUARTZ*, Ibid. p. 179.

This rock, which we have ſo often obſerved in the iſlands of Iſla and Jura, is deſcribed by Dr Walker under the name of Cyamea Juræ; and, more lately, Mr Kirwan, in his Geological Eſſays, deſcribes ſimilar rocks under the names of Arenaceous Quartz and Primitive Sandſtone. There are many ſpecies of this rock in theſe iſlands; but I will only mention three of the moſt remarkable.

1. COM-

1. COMPACT.

Colour. White, or grey.

Luſtre. Little glancing.

Tranſparency. Tranſmits light at the edges; but when the ſpecimen is thin, the light paſſes through the whole.

Hardneſs. Strikes fire with ſteel.

Fracture. Even, coarſe ſplintery, and frequently ſhiſtoſe in the groſs.

Intermixed with quartz, (which is ſo compact as to render the granular character difficultly obſervable,) I always obſerved a number of white ſpecks, which are either felſpar or mica, or both, uſually in a ſtate of decompoſition. Sometimes veins of compact quartz are to be obſerved traverſing this ſpecies.

2. MICACEOUS. This ſpecies is compoſed of quartz, and a ſmall portion of mica. The mica is always in ſmall ſcales, and is either yellow, brown, or white. Often the mica is ſo abundant, that we have a true micaceous ſhiſtus.

3. GRANITIC. In this ſpecies, the granular appearance is more evident: and, intermixed with the quartz, are numerous cryſtals of red and white felſpar, of various ſizes, from a pin-

 head

head to half an inch; and a few ſcales of mica alſo, now and then, occur. Not unoften cubical cryſtals of iron pyrites are intermixed with the other ingredients, and, by their decompoſition, cauſe the ſtone to acquire a brown colour, or to diſintegrate altogether. This ſpecies, therefore, is to be reckoned an approximation to the granite, from which it differs but in the proportion of felſpar and quartz.

MICACEOUS SHISTUS.

This rock occurs in Iſla and Jura, and is conſiderably varied in its appearance. The quartz is of various colours, as black, blue, or white; and is generally granular. The mica is alſo of different colours, as black, brown, greeniſh, or white: the ſcales are, in general, ſmall; the largeſt are thoſe in the rocks in the ſtrata that extend to the north end of Jura. The micaceous ſhiſtus at Lag in Jura, at a diſtance, is not unlike baſalt; but a nearer examination diſcovers a compound of black and dark-blue coloured quartz, with ſmall ſcales of black mica very cloſely compacted together. It often alſo contains iron pyrites, which, by its decompoſition, forms a number of ruſt-coloured ſpots. Sometimes cryſtals of felſpar occur when it paſſes to gneiſs; or the quantity of quartzy particles increaſe when it paſſes to the ſtate of arenaceous quartz.

ARDESIA.

ARDESIA.

Colour. Bluifh or blackifh grey.

Luftre. Silky. This filky glofs, Mr Kirwan remarks, intimates magnefia.

Tranfparency. None.

Fracture. Streight, flaty ; the laminæ are undulated upon the furface.

Hardnefs. Eafily fcraped with a knife : but this degree of foftnefs is probably owing to the influence of the weather, as the fpecimen now defcribed was taken from the furface of the ftratum.

Streak. Grey.

Smell. Emits a ftrong earthy fmell when breathed on.

Cubical cryftals of iron pyrites are difperfed through it ; and thefe, by the efcape of the fulphur, are converted into brown iron ore. It is worthy of remark, that the pyrites which occurs in the primary ftrata is much lefs liable to decompofition than that which we find in the fecondary ; and farther, that altho' we find pyrites very abundant in the primary ftrata, yet the combinations of the fulphuric acid with earths are rarely to be obferved.

obferved *. Mr Kirwan, in the fecond volume of his Mineralogy, explains to us the difference between thofe pyrites that efflorefce and decompofe quickly, and the others which decompofe more flowly. He remarks, that thofe pyrites which efflorefce fpontaneoufly, contain iron in a metallic ftate; but the others which decompofe more flowly, and by the feparation of their fulphur, have the iron in the ftate of an oxyd.

CHLORITE SHISTUS.

Slaty Chlorite, Kirwan's Mineralogy. *Argilla Chlorites Shistosus*, Werner.

Colour. Dark-green.
Internal Luftre. Little glancing.
Tranfparency. None.
Fracture. Slaty; lamellæ pretty eafily feparable.
Hardnefs. Yields eafily to the knife.

Streak.

* Gypfum has been difcovered mixed with mica in Mount St. Gothard; 44 J. de Phyfique. Pallas has obferved gypfum affociated with felfpar in Siberia; 5 Nord. Beytrage. Sulphat of Barytes has been obferved in gneifs in the mountains of Savoy, as mentioned by Werner. Thefe are the few inftances that are known.

Streak. Green.

Smell. Has a ſtrong earthy ſmell, when breathed on.

Frequently grains and layers of quartz are to be obſerved mixed with the chlorite; and ſometimes the quartz is penetrated with it, forming a foſſil not unlike praſe. Iron pyrites are ſometimes intermixed with the chlorite, and, by their decompoſition, colour the rock brown. Cryſtals of green hornblende are alſo to be obſerved intermixed with the chlorite; and according to the quantity of hornblende, the rock paſſes more or leſs to the ſtate of hornblende rock.

FOLIATED CHLORITE.

Blattriger Chlorite, Werner, Eſthner's Mineralogie, Emmerling's Mineralogie.

The *colour* is that of the common chlorite.

It is found not only maſſive, but alſo diſperſed, and cryſtallized.

The cryſtals are in the form of a double conical pyramid, with truncated apices; and are to be obſerved alſo in the form of a cylinder, with a cone or conical pyramid upon each extremity.

The

The cryſtals are ſmall, with little luſtre on the outſide, but ſtrong glancing † internally.

Luſtre. Intermediate between the greaſy and mother of pearl.

Fracture. Foliated ; but moſt commonly curved foliated.

Tranſparency. Semi-diaphanous ; or ſuch as to permit light to paſs thro', but ſo little that objects cannot be diſtinguiſhed.

Hardneſs. Not eaſily ſcratched with the nail, yet yielding eaſily to the knife.

Fragments. Tabular ; feels a little fatty ; and is not remarkably heavy.

It is found inveſting white-coloured quartz, but more commonly well cryſtallized in cavities of the quartz. I have only obſerved it in the iſland of Jura, among the ſtrata of chlorite ſhiſtus, upon the road from Ardfin to the harbour of the Small Iſles. According to Emmerling, it is a very rare foſſil ; as it has been obſerved in one other place only, that is, upon the mountain of St. Gothard, in Switzerland, where it is accompanied by cryſtals of adularia, reddiſh-brown ſchorl, and rock cryſtal.

HORN-

† Stark glänzend.

HORNSTONE.

Achates Petrosilex, Lin. *Silex Corneus*, Wern. *Nicomia*, Dr Walker. *Chert*, Angl.

Colour. Pale brown; in ſome parts green, when intermixed with the magneſian rock in which it lies.

Luſtre. None.

Tranſparency. Tranſmits a little light at the edges.

Fracture. Fine ſplintery.

Hardneſs. Strikes fire plentifully with ſteel.

Where it is in contact with the magneſian rock, it is much intermixed with it, has a green colour, and at length fairly paſſes into the talcaceous ſhiſtus of which the iſland is formed. Sometimes we find veins of cryſtallized calcareous ſpar traverſing it.

TALCÁCEOUS SHISTUS.

Lapis Ollaris, Waller. *Talcum Ollaris*, Lin. *Talc Scheifer*, *Verharteter Talc*, Germanor. *Talcum Proprium Ollari*, Werner.

Colour. Dark-greeniſh black, or yellow.

Luſtre. Nearly as ſhining as ſilk.

Tranſparency. Sometimes tranſmits a little light at the edges; in other ſpecimens, when it paſſes to ardeſia, it is opaque.

Fracture. Shiſtoſe.

Hardneſs. Yields to the knife eaſily; but, as it paſſes to the ſtate of argillite, becomes harder.

Streak. Grey.

This rock is to be obſerved paſſing, upon the one hand, to the chlorite ſlate, and, on the other, to ardeſia. It is found in different parts of the iſlands of Iſla and Jura, as has been mentioned in the preceding chapter.

LIME-

LIMESTONE.

Colour. Dark blue.

Luſtre. Very weak, principally from a few ſhining particles diſperſed through it.

Tranſparency. None.

Fracture. Even, fine ſplintery.

Hardneſs. Yields with ſome difficulty to the knife.

Streak. Grey.

It forms the central part of the iſland of Iſla, and contains no petrifactions; which renders it probable that it is of primitive formation. It may be objected to this, that all primitive limeſtones have a ſcaly or granular grain. We cannot doubt that, in general, this obſervation is perfectly correct; but it ſeems liable to exceptions: as Mr Kirwan, in his Geological Eſſays, mentions, upon the authority of the Helvetic Magazine, that the mountains of Wetterhorn, Wellhorn and Burghorn are formed of primitive limeſtone having a ſplintery fracture; and I ſhall afterwards mention primitive limeſtone, or marble, with a ſplintery fracture, as occurring in the Hebrides. Mr Kirwan further mentions, that, as ſome traces

of muriatic acid are to be found in ſecondary limeſtone, and none in the primary, this may ſerve as a good teſt for diſtinguiſhing them. I have not, however, made any experiment, with this view, upon the Iſla limeſtone.

COMPACT MARL—STONE MARL.

Verharteter Mergel, Germanor. *Calcareus Marga Indurata*, Werner.

Colour. Yellow, or yellowiſh white.

Luſtre. None.

Tranſparency. None; but, when much penetrated with ſiliceous matter, tranſmits a little light at the edges.

Fracture. Fine ſplintery.

Hardneſs. Yields with difficulty to the knife; and, when penetrated with ſiliceous particles, ſcarcely yields to the knife.

Is ſlowly acted upon by acids, and feels heavy.

It is uſed for the purpoſes of agriculture, but it requires ſeveral years before it falls.

MELAN-

MELANTERIA, Pliny—BLACK CHALK.

SHISTUS *fcriptura atra, ater inquinans*, Linn. *ARGILLA NIGRICA*, Werner. *SHISTUS NIGRICA*, Waller. *MELANTERIA*, Dr Walker.

Colour. Bluifh black.

Luftre. Longitudinal fracture extremely little glancing, and the crofs fracture none.

Fracture. Longitudinal fracture, curved flaty; but the crofs, fine earthy.

Streak. Little glancing. Colours black, but without the luftre of plumbago.

Hardnefs. Pretty eafily fcratched with a knife.

This foffil occurs often in the neighbourhood of aluminous fhiftus; and is always found, difpofed in beds, in the primitive mountains, particularly in ardefia. As it writes upon paper, and has a bluifh-black colour, it has often deceived the uninformed, who have imagined they have difcovered black lead: the difference of luftre, and other characters, however, fufficiently diftinguifh them. It has alfo been taken for coal, or reckoned a proof of the vicinity of coal ftrata. Thus, Dr Reufs,

Reufs †, in travelling through Bohemia, tells us, that he obferved a fhaft funk feveral fathoms through ardefia, and, upon enquiry, he found it was in fearch of coal. This coal, however, upon examination, he found to be a fpecies of aluminous flate, very nearly refembling black chalk. This fhould ferve as a ftrong caution againft making trials, without having firft examined carefully the rocks which we think indicate the prefence of coal; and farther, whenever any coal-like fubftance (which was the cafe here) is obferved only among primitive rocks, it fhould excite a ftill ftronger doubt, when we recollect that coal has never yet been detected, nor probably ever will, in any quantity, in primitive mountains.

SEIL,

† Mineralogifche Geographie von Boehmen, Zweiter band, § 202.

SEIL, EASDALE AND OBAN.

CHAP. XII.

Voyage from JURA *to the Slate Iſlands of* SEIL *and* EASDALE; *thence to* OBAN *and the Iſland of* MULL.

HAVING found it very inconvenient to examine the weſt and northern parts of Jura, Mr Macnicol, the miniſter of the iſland, (to whoſe kindneſs we were much indebted,) procured a boat, and we ſailed from the harbour of the Small Iſles to the iſland of Seil, a diſtance of about 30 miles. As the weather was charming, we kept cloſe along the ſhore of Jura, which gave us an opportunity of landing upon different parts of the iſland. Having reached the northern extremity, the wind increaſed a little; ſoon after, we heard the great whirlpool, the Coryvrekan, raging, in the ſound between Jura and the iſland of Scarba.

We

We now paffed the rugged ifland of Scarba, which is apparently compofed of micaceous fhiftus traverfed by bafaltic veins; next, the ifland of Luing, faid to afford much ardefia; foon after, the fmall ifle of Balinahuia, where there is an extenfive quarry of ardefia; and, at fome diftance, we obferved the ifland of Garveloch, where there is a confiderable quarry of fhiftofe marble*, firft difcovered, many years ago, by Dr Walker. After much oppofition from an extremely violent tide, we at length landed upon the ifland of

SEIL.

THIS ifland, about 3 miles long, and 2 miles broad, is feparated from the ifland of Eafdale by a ftrait a few hundred feet broad, and from the mainland by a narrow pafs over which a bridge has been thrown. The ifland is in general flat, yet not without hills, from the higheft of which we have a pleafant view, of the many

* This marble rifes in flags of a confiderable fize, fome 3 feet by 2, and even 4 feet by 3; takes a good polifh; and is of a white or grey colour, and is fometimes clouded; and has a fine grain.

ny fmall ifles fcattered over the ocean, with the diftant mountains of Mull and Jura.

The greater part of the ifland is compofed of rocks of primitive formation, and thefe are micaceous fhiftus and ardefia. Bafaltic veins are alfo very frequent, traverfing both kinds of ftrata ; and, where the ftratified matter is wafhed away, or has fallen down by decompofition, the perpendicular veins appear often like bafaltic crags, and, at firft fight, may be taken for ftrata. Confiderable veins of quartz are alfo to be obferved traverfing the primary ftrata upon the fouth and eaft fhores of the ifland ; and, near to the fouthern extremity, I obferved a vein of quartz which contained a quantity of iron pyrites, but apparently too fmall to be of any importance.

Befides thefe primary ftrata, I obferved, upon feveral parts of the ifland, fmall portions of the tranfition (uebergangsgeburge) and flotz rocks (flotzgeburge). Near to Mr Campbell's houfe, I obferved the ardefia covered by grauwacken, and both apparently traverfed with the fame bafalt vein ; which leads us to fuppofe that they were formed at the fame time ; and, in fupport of this, I may mention, that German mineralogifts have obferved thefe rocks to alternate *. Upon the fide of the

 ifland

* Emmerling, Band. 3. § 105.

they are divided into quarriers and day labourers. The quarriers are paid annually at a certain rate for every thoufand flates: from 10d. to 15d. I believe, as their work has been attended with more or lefs difficulty. The day labourers are employed at the company's expence in opening new quarries, and have from 10d. to 1s. a day.

OBAN.

AS the weather continued very pleafant, we preferred going to Oban by fea, in place of the circuitous rout by land. Having procured a boat, we left Seil, with a fine breeze; our voyage was agreeable, with fcenery often ftriking; on one hand, was the lofty coaft of Mull, extending from Loch Bay to Crogan, all apparently bafaltic; on the other, the mainland rifing into fmall hills, alfo with a bafaltic afpect. Having paffed the ifle of Kerrera, which lies acrofs the bay of Oban; in a fhort time afterwards, we landed at the village. The bay of Oban is of a femicircular form; is from 12 to 14 fathom deep, with good anchoring ground, and will contain 500 fail of

of merchant ſhips. The village is pleaſantly ſituated at the upper part of the bay, a ſtation excellently adapted for the fiſhing. The decline of this branch of trade, has indeed been unfavourable to the riſe of Oban; but it is, notwithſtanding, the moſt conſiderable village on this part of the coaſt, containing about 586 inhabitants. It is to the exertions of the two brothers, the Meſſrs. Stevenſons, who ſettled here in 1778, that Oban is chiefly indebted for its preſent flouriſhing condition.

As we were anxious to proceed on our journey through the iſlands, well knowing the variable ſtate of the weather in theſe highland countries; we took but a glance of the rocks in the neighbourhood of Oban. The ſtrata immediately upon the ſhore, on both ſides of the town, are formed of dark blue coloured argillaceous ſhiſtus; immediately above this, I obſerved in ſome places baſalt, or baſalt porphyry. As we approach Dunolly caſtle, which forms the extreme point of land upon one ſide of the bay, vaſt rocks of breccia appear; and theſe continue all the way to Dunſtaffnage caſtle *. Both theſe caſtles

* At Boregonium, which is a few miles from Dunſtaffnage, there are, according to Dr. Garnet, undoubted volcanic appearances. Dr Walker informs me, that the pumice, which Dr. Garnet mentions, is the ſcoriae from the iron furnaces, which were worked at that place by our anceſtors.

tles are built upon rocks of breccia, which is compofed of varioufly fhaped pieces of granite, micaceous fhiftus, and fandftone, connected by an arenaceous breccia. Upon different parts of the coaft, and in the interior of the country, this breccia feems to lye upon a red coloured argillaceous fandftone. From Oban, the country becomes gradually higher as we approach the great mountain of Cruachan; and the ftrata alfo change. If we walk by the Inveraray road, we obferve wacken, and fometimes bafalt covering the fandftone; and in many places great rounded maffes of granite, which formerly conftituted part of the breccia, are to be feen fcattered about. Thefe fandftone and bafalt ftrata, probably continue until ardefia and micaceous fhiftus, which form the lower region of Cruachan, make their appearance; and this is fucceeded by the granite, which rifes through it, and continues to the top of the mountain *.

Mr. St. Fond has given us a chapter upon the lithology of Oban, in his travels through Scotland; but he has here, as ufual, intermixed his theoretical fpeculations with the defcriptions of the ftrata. He denominates the blue argillaceous fhiftus

* I owe this information, with regard to Cruachan, to my friend Mr. Caddell.

ſhiſtus of Oban, a limeſtone; this, he ſays, is an aquatic production; but the baſalt, he imagines to have been ſuperinduced in a melted ſtate under water, which prevented the limeſtone from being altered; and further, he deſcribes the breccia as a volcanic matter, which has been thrown up in a ſimilar manner with thoſe volcanic erruptions "in which water heat-"ed to the higheſt degree of ebullition, enters into concourſe "with fire, and the different elaſtic emanations generated by "ſubterraneous combuſtion." I muſt confeſs my inability to comprehend this explanation; at any rate, it is now uſeleſs to attempt ſupporting this part of the volcanic theory, as it has been demonſtrably refuted by Mr Kirwan, in his paper on baſalt.

Voyage to Mull.

HAVING arranged every thing for the continuance of our journey, we ſet ſail for the iſland of Mull, which is about 15 miles from Oban. In our way, paſſed near to the iſle of Kerrera, of which Faujas gives the following account. "A part "of this iſland is volcanic; on the coaſt fronting Mull, there

"are

" are collections of compact lavas in masses, and in large cur-
" rents. This basaltic lava appears sometimes in the form of
" prisms, which are not very regular; at least in the places I
" had an opportunity of examining. I also found some rocks
" of micaceous shistus of a whitish colour, and others which
" were greenish, with a porous texture. These shistus, or
" gneiss, are composed of quartz, steatites, and small scales of
" mica.

" Near the rock of micaceous shistus, there is found com-
" mon slate of a deep grey colour, approaching to black; the
" beds of which are almost even with the ground; quar-
" ries might easily be opened here with great advantage to
" the country. They would even become an object of com-
" merce. Among the slate, there are found some brilliant
" pyrites, the crystallizations of which are cubical ‡."

We next passed the island of Lismore, which is about nine miles long, but very narrow: it is according to Williams, composed entirely of limestone, traversed with basaltic veins. Dr. Mitchell supposes that the limestone belongs to the transition rocks.

‡ Travels through Scotland, &c.

rocks (uebergangsgeburge). From the greater part of the ifl-and being formed of limeftone, at the fame time well fhelter-ed, it is rendered one of the moft productive fpots in the Highlands. After a fhort voyage, we came clofe in with the coaft of Mull, but on account of the tide, we were obliged to pull along the fhore for fome miles, which gave me an oppor-tunity of examining the fhore, until we landed on the coaft below Achinacraig.

MULL.

CHAP. XIII.

Outline of the MINERALOGY *of the Iſland of* MULL.

THIS iſland is about 22 miles long, and 16 miles broad. It is reckoned by ſome writers to be the Maleos of Ptolemy *; and Cambden is of opinion, that it is the Mille of Pliny ‡. On the north, it is bounded by Ardnamurchan; on the eaſt, by the rugged ſterile looking mountains of Morven, and the iſle of Liſmore; to the ſouth, are the iſles Jura, Scarba, and Slate iſles; and on the weſt, I-kolmkill, Staffa, Coll, and Tiree.

The coaſt of this iſland is much diverſified in its appearance; in many places we obſerve a great extent of ſteep and bold rocky

* Campbell's Political Survey, vol. I. p. 599.

‡ Britannia, p. 848.

rocky ſhores, forming tremendous precipices; particularly upon the ſouth ſhore near Loch Buy. Often the ſhores are low, but ſtill rocky and dangerous; ſeldom is there any ſandy beach, the coaſt being generally covered by the immenſe maſſes that have fallen from the neighbouring cliffs. It is low, however, towards the S. W. extremity which is called the pariſh of Roſs.

The iſland is very mountainous, and ſome of the mountains riſe to a conſiderable height; particularly Ben-More, which is reckoned the higheſt in the iſland. It is much interſected upon the weſt ſide, where there are two conſiderable lochs or arms of the ſea, called Loch Skriddan, and the other Loch-na-gaul.

Mineralogy. Achnacraig, where we landed from Oban, is ſituated at a little diſtance from the ſea ſhore, with ſome conſiderable flats near it; and theſe being cultivated, and in ſome places wooded, enliven the ſcene conſiderably. The rocks are in general baſalt and wacken, which are in many places traverſed with baſaltic veins. The occurence of veins of baſalt croſſing a ſimilar rock, ſeems to be very rare; as I am well informed, that foreign mineralogiſts, have never obſerved ſuch appearances. Mr Faujas St. Fond, in deſcribing

this part of the iſland, ſeems to have been much ſtruck with one of theſe veins, which he compares to a circus; and has given a long detail of the way in which it may have been formed. This was all very unneceſſary, as this vein does not differ from many others to be obſerved in the iſland; and the idea which Mr St. Fond raiſes of its magnificence, is far ſtretched—it is trifling when compared with the grand appearances upon the coaſts of Iſla and Jura. As we advance towards Loch Speleve, the cliffs upon the ſhore do not increaſe much in height; but there are land cliffs behind them conſiderably higher. The rocks are almoſt entirely of baſalt and wacken, all the way to the loch, as alſo the hills in the neighbourhood. About half a mile from Achnacraig, I obſerved a ſtratum of blue coloured limeſtone, covered with calcareous ſandſtone; but theſe ſtrata are viſible only for about 80 feet, when they are loſt under the baſalt. This limeſtone contains in it belemnites, and is therefore to be reckoned with the tranſition rocks; and is what Mr Kirwan conſiders as the moſt ancient of the ſecondary ſtrata*.

As there is a good road, along the ſhore of the iſland, from Achnacraig to Tobermory, we preferred it to coaſting by ſea. Having

* Geological Eſſays, p. 226.

Having left Achnacraig, we paſſed, for about a mile, through little wooded glens, which are extremely pleaſant, particularly in a country where wood is truly a rarity. The ſtrata ſtill continued baſaltic, excepting at one place where I obſerved a ſtratum of blue-coloured limeſtone cropping thro' the ſoil. As we journeyed along the ſhore at the bottom of the high hills which bound it, I judged it neceſſary to examine ſome of them to their ſummits; that I might obtain more diſtinct information of their nature, and have an opportunity of ſurveying the neighbouring country. The day being fine, we began to aſcend a high hill, about two miles from Achnacraig. The aſcent was very ſteep, until we reached an extenſive plain ſeveral hundred feet above the level of the ſea. The ſtrata, to this height, were baſalt and greenſtone, and both frequently traverſed with baſaltic veins. The greenſtone, even at a conſiderable diſtance, has a ſingular ſcorified-like aſpect, from the felſpar having decayed, and the remaining hornblende, reſembling a dark green, or blackiſh cellular maſs, not unlike the ſcoria of an iron furnace. The plain was covered, to its whole extent, with looſe ſtones of an iron-brown colour. Hardly a trace of vegetation could be ſeen; and the deep ſilence of this deſert was diſturbed only by the ruſhing of the cold piercing wind acroſs the mountain. The looſe maſſes of rock juſt mentioned, I found to be of breccia, which is compoſed of variouſly

riously shaped masses of quartz, earthy felspar, hornstone, and granite, connected by a basalt or wacken ? basis ‡. It is probably of the nature of basalt tuff; which, according to German mineralogists, is a rock with a basalt or wacken basis, having, immersed, fragments of other rocks, as granite, quartz, &c. We now walked towards the summit of the mountain, which we reached, after having passed over a succession of smaller plains, or platforms, separated from each other by steep basaltic craigs. The summit is composed entirely of basalt, which contains much hornblende; and this rock has the property of reversing the compass at a considerable distance, and even in detached pieces. From this elevated situation we had a fine view of the island. Towards Tobermory the mountains appear to become gradually lower; but, upon the west side, a tremendous groupe of variously-shaped mountains appears before us, and among them Ben-more rises with much dignity. The glens, which we observed run from the mountain, are of great depth, very steep, and apparently composed of strata of basalt and greenstone. These strata, however, run in a direction contrary to that of the vallies, which intimate that the land has

‡ I am obliged to mark this doubtful, as I unluckily lost the specimens, which would have enabled me to determine the nature of the basis.

has ſunk down, as we have already explained in our ſpeculations upon the formation of the bed of the Clyde. We now deſcended from the mountain, but by a different route from that which we followed in aſcending; and although it was fatiguing and difficult, it afforded us an opportunity of obſerving the baſalt and greenſtone alternating with each other, and elevated nearly to an angle of 45°.

We now continued our journey along the Tobermory road, with hills upon one hand, but in a ſhort time the land on the other became low, ſtretching out towards the ſound of Mull, to a point on which is ſituated Duart Caſtle. The hills, as alſo the hills near the ſhore, are ſtill baſaltic; but we were informed that there is, at the caſtle, a great ſtratum of limeſtone, which affords cornua ammonis and ſhells. As we approached Achnacroſh, we obſerved, upon the ſhore, ſtrata of argillaceous ſandſtone, with interſperſed bituminous and coaly matter, as is uſually the caſe with ſandſtone in coal countries; and, at a little diſtance, a rock, which ſeems to be analogous to greenſtone, of which a particular deſcription is given in the following chapter.

From this to Arros the ſhores are low, but the hills riſe to a conſiderable height; and both are formed of baſalt, greenſtone,

and

and wacken, which I ſometimes obſerved traverſed with baſaltic veins. The baſalt, but more particularly the wacken, contains zeolite, which is either compact, fibrous, or cryſtallized. I regretted extremely that I had not an opportunity of examining this part of the country more particularly, as there can be no doubt but that it would afford much curious information with regard to the rocks of trap formation. I have however to offer as an apology, (if ſuch a thing is becoming,) that, in travelling over all that track of country, we were envelopped in thick clouds and pouring rain; ſo that the few obſervations as to the nature of the hills, were made by examining the debris in the ravines, or were now and then aſſiſted by the partial diſperſion of the clouds. I may now alſo remark, that, in travelling theſe countries with a view to the particular examination of their mineralogy, it will be abſolutely neceſſary for the traveller to carry along with him a tent, and other conveniences, ſo that he may encamp among the mountains, and examine them leiſurely, and with that ſcrupulous accuracy which the importance of the ſubject requires.

At Arros there is a ſmall colonade of baſalt, upon which there are ſtill the remains of an old caſtle, once inhabited by Macdonald prince of the Iſles. In the bed of the river of Arros, (a ſmall ſtream of water which comes from the neighbouring

baſaltic

bafaltic hills,) I obferved numerous blocks of granite, fimilar to thofe upon the hill near Achnacraig. Thefe blocks feem to be derived from a bafalt tuff fimilar to that obferved near Achnacraig; and it is probable that fuch a rock may be difcovered in the neighbouring hills. It will be an object worthy the attention of future travellers, to afcertain, whether this bafalt tuff? merely covers the bafalt, as has been obferved by Reufs in the mountains of Bohemia, or alternates, as is the cafe with the bafalt tuff in the ifle of Canna, and in other parts of Scotland. It matters not in which of thefe fituations it be found: it is ftill to be confidered as a fecondary rock, and, like thefe, to have been depofited from an aqueous fluid. Probably fome may think that thefe maffes have been feparated from the decompofing bafalt itfelf, as it fometimes contains pieces of granite. This, however, is an appearance fo rarely to be obferved in this ifland, that I can hardly imagine the granite blocks to be derived from that fource.

Profeffor St. Fond has fpeculated upon this fubject, as he obferved fimilar appearances in different parts of the ifland. For the information of my readers, I will extract the following paffage from his Travels. " Thefe lumps of granite (fays he) may have been " ejected from granite quarries, which perhaps exifted at great

" depths under theſe ancient volcanoes, by the exploſions which
" took place at that epoch, when extenſive combuſtions waſted
" theſe countries, and formed groups of iſlands, which ſeem
" to have the ſame origin.

" It is, beſides, within the verge of poſſibility, that thoſe
" parts of the mountains where they are now found were not,
" at that period, elevated ſummits, but rather formed part of
" the bottom of the ſea, and that theſe granite blocks were
" rolled from a diſtance by the currents. It is poſſible that
" circumſtances of ſubterraneous exploſion, equally terrible
" with thoſe which formed the iſle of Santorini in the Archi-
" pelago, or Montenove in Italy, may have raiſed up the bot-
" tom of the ſea into volcanic peaks; or, if it ſhould appear
" more plauſible to ſome, we may refer to a period when
" mountains ſtill higher were covered by the ſea: a fact, which
" cannot be doubted, ſince marine bodies are found in great
" abundance in beds of limeſtone, or clay, ſituated on the Alps
" or Appenines, at a height three or four times greater."

At Arros, we changed our route; and in place of going on to Tobermory, we took our courſe acroſs the iſland to Luggan Ulva. The road, which is but indifferent, leads us among hills of no conſiderable height, to the plain of Knock, ſitu-

ated

ated at the head of Loch-na-gaul. The hills are compofed of ftrata, of bafalt, and wacken; which are fometimes traverfed with bafaltic veins. The loch, which is of confiderable extent, is bounded upon one fide by the mountain of Ben-more, with other neighbouring hills, that extend towards the fea fhore, forming lofty crags, not unlike thofe of Salifbury Hill near Edinburgh; on the oppofite fide, are the hills that bound the road which leads towards Luggan Ulva. Ben-more, which is the higheft mountain in the ifland, is of confiderable magnitude; and Mr St. Fond remarks that it has much the appearance of the famous volcanic mountain Vesuvius. We did not afcend this mountain, fo that I cannot give any account of the rocks of which it is compofed; but I have had the opportunity of examining fpecimens brought from it by Mr. Caddel. It would feem from thefe, that it does not differ from the other parts of the ifland which I have already defcribed, being compofed of bafalt and greenftone; even to its very fummit. This agrees pretty nearly with the obfervations of Mr. St. Fond, who tells us, that it is compofed of lava; that is bafalt. We purfued our journey along the oppofite fide of the loch, which led us to Luggan Ulva; I found little variety of rock; the bafalt and wacken ftrata traverfed with bafaltic veins, ftill continu-

ing. The wacken, however, affords many beautiful fpecimens of zeolite, and alfo a rarer foffil, the prehnite.

Nearly oppofite to Luggan Ulva, lies the fmall ifland of Ulva, which is evidently compofed of the fame rocks; and farther diftant, is the ifle of Geometra, which is alfo bafaltic.

As foon as the weather, which had been for fome time tempeftuous, became moderate, we croffed at the mouth of Loch-na-gaul, and landed immediately under the high cliffs, which we had feen from the head of the loch. We now walked along a confiderable extent of fhore, which is bounded by lofty crags, compofed of bafalt and wacken ftrata, and both traverfed by bafaltic veins, which run in very different directions. Immediately upon the fhore, I obferved ftrata of argillaceous fandftone, and fandftone breccia; and we were told, that both coal and lead had been difcovered in feveral places in the neighbourhood. About 200 feet above the level of the fea, on the tract which takes us acrofs the mountains to Loch Skriddan, our attention was arrefted by the appearance of a curious fpecies of breccia. It is compofed of fragments of quartz, micaceous fhiftus, compact limeftone containing flint, and the whole cemented by an arenaceous bafis; fometimes it has a calcareous bafis, when it has a yellow colour, owing

to

to a decompofition of the limeftone. Below the breccia we obferved a compact micaceous fhiftus. In going higher up, we had a more diftinct view of the ftratification; which is as follows: 1. Micaceous fhiftus. 2. Breccia covering the micaceous fhiftus. 3. Sandftone, more or lefs of the nature of breccia, covering the breccia. 4. And higher up the mountain appeared the bafalt; but we could not determine correctly its fituation with regard to the ftrata juft mentioned. The appearance of micaceous fhiftus in a bafaltic country, is a fingular phenomenon, well deferving the attention of future travellers.

From this, we continued our journey in the direction of the great Bourg head, (a lofty promontory at the entrance of Loch-fkriddan,) over which we croffed, and defcended to the fhore of Lochleven or Skriddan. The ftrata in this tract are ftill bafalt and wacken; and both are traverfed with bafalt or wacken veins; and contain much zeolite. I accidentally difcovered a piece of black pitchftone porphyry, fimilar to that which is found in Glencloy, in the ifland of Arran. This Loch, which is pretty extenfive, is bounded on both fides by bafaltic hills; and at its upper extremity, there is a grand groupe of bafaltic hills that congregate nearly to the oppofite fide of the ifland, about Loch Spelve. We croffed the loch

near

near its mouth, and walked along the ſhore, which is low and baſaltic, until we approach Artown, when it juts out into a promontory, which preſents ſeveral very beautiful ranges of baſaltic columns. Upon the N. E. ſide of the promontory, we obſerved, immediately upon the ſhore, a ſtratum of coal, which has for its roof a maſs of imperfectly ſhaped baſaltic pillars; and its floor is alſo baſalt. The ſtratum is about 12 inches thick; and ſometimes interpoſed between it and the baſalt there is a thin layer of blaes (ſhiſtoſe clay), which is mixed with the coal, and deteriorates its quality. We could only obſerve the ſtratum running for a ſhort way, as the ſea has thrown up debris along the bottom of the rocks, where the coal is ſituated: yet we were told, that it is to be ſeen cropping out upon other parts of the coaſt. As the country is low in the neighbourhood of the coal; it is certainly worthy the attention of the proprietors, to endeavour by trials ſkilfully conducted, to know how far this ſtratum extends; and whether other ſtrata exiſt near to it. It has been objected to this, that if any trials ſhould be made, it would merely ſatisfy curioſity, without the probability of ſucceſs; as it is imagined that baſaltic rocks are very unfavourable to coal. We cannot deny the fact, that coal is ſeldom ſo regular under baſalt, as under ſandſtone; yet, in a country where the beſt part of the year is waſted in the operations of cutting and drying peat, there

there can be no doubt, that the difcovery of a bed of coal, (although it fhould not be fo extenfive as thofe in the fand-ftone countries), would be of the higheft importance.

We are further encouraged to make regular trials, when we know that in other parts, confiderable beds of coal have been found among fimilar rocks. Thus at Borrowftounnefs, according to Mr. Williams, we find thick ftrata of bafalt interpofed between beds of coal, which are worked to a great extent: and in the Bathgate hills, coal and bafalt alternate with each other *. In Bohemia, according to Reufs, coals inlaid in bafalt are worked †; in the Faroe iflands, coal is found in ftrata among bafalt ‡: at Meiffen, in Heffia, a bed of coal from 6 to 90 feet, is found covered with bafalt, to the height of 600 feet ‖.

Mr Mills, in the paper which I have already mentioned, when defcribing Ifla and Jura, gives an account of a remarkable appearance near Artown, which unluckily I had not an opportunity of viewing. As it will be interefting for future travellers

* Williams's Mineral Kingdom, vol. 1. p. 70.

† Mineralogifche Geographie von Boehmen.

‡ Haidinger Gebergsarten.

‖ Bergm. Journ. 1792, 319, and Kirwan Geological Effays, p. 311.

travellers, I ſhall here inſert his deſcription, and make a few obſervations on it.—“ About a quarter of a mile from the “ ſpot where the bearings were taken, is a deep glen, running “ N.N.E. to the ſea. It is about 30 yards in length, and 20 in “ breadth. The ſtrata are diſpoſed in the following manner: “ The uppermoſt is 10 yards of lava, with horizontal diviſions, “ and vertical joints, taking the form of rude pillars. Under “ this, is a horizontal bed of perfectly vitrified ſubſtance, “ which appears to have been a ſhale, and is from 1 to 2 inches “ in thickneſs. Beneath this, is about three yards of ſiliceous “ gravelly concrete; below which, are horizontal beds of in- “ durated marle of various thickneſs, from 6 to 12 inches. “ The whole of theſe beds taken together, are about four “ yards; and there is a large fiſſure in them, on the weſt ſide of “ the glen. Laſtly, are 10 yards of rude lava, containing ſpecks “ of quartz, and mica unaltered; pieces, apparently of gra- “ nite; and in ſome, nodules of calcined chert. The whole is “ incumbent on regular baſalt pillars of various dimenſions, “ from 18 to 6 inches in diameter, varying in their number of “ ſides; ſome having 5, ſome 6, others 7, &c.” This gentle- man, by denominating his foſſils upon theoretical principles, has thrown a conſiderable degree of obſcurity over his deſ- cription. To me, the following appears to be the true ac- count:—

Lava.—This is probably basalt: for he appears to use this term in different parts of his memoir, as expressive of all kinds of basalt.

Vitrified substance.—This is certainly the same with the black pitchstone which we have already observed upon the opposite side of Loch Skriddan; and which we were told had been found near Bunesan and at Bennenoch.

Siliceous gravelly concrete.—Probably a coarse sandstone? If this supposition be correct, it is another example of pitchstone being contained between sandstone and a rock of trapp formation, similar to that I suspected in the island of Arran.

Indurated marle.—This is probably the same with the limestone, which contains flint upon the coast between Loch-na-gaul, and Loch-Skriddan.

Calcined chert.—This is likely hornstone; which, however, is a rare occurence in basalt. Emmerling. B. 3. § 187.

We now left Artown, and walked on to Bunesan; the country still continued to be formed of basalt, containing many

beautiful ſpecimens of zeolite paſſing to chalcedony, and alſo prehnite. Near to this place, there is a little river which marks the termination of the ſecondary, and the beginning of the primary ſtrata. Upon the eaſt bank, I obſerved the baſalt; but upon the weſt, the ſtrata are of micaceous ſhiſtus. I endeavoured, as far as my ſhort time would allow me, to diſcocover the junction of the ſtrata, but was not ſo fortunate as to obſerve them in actual contact: yet, I think it not improbable, that the baſalt lies upon the micaceous ſhiſtus. This ſuppoſition, may to ſome appear to invalidate the obſervation I have made in a former part of the work, viz. that baſalt is never found among primary ſtrata. This is by no means the caſe; for here, the baſalt forms a great extent of country; and in ſome places, as at Artown, it contains coal; ſo that, although it lies on micaceous ſhiſtus, without any intervening breccia, it cannot be conſidered as primitive. It appears to me a good mode of aſcertaining whether a rock be primary or ſecondary, to examine whether it alternates with ſtrata decidedly primitive; and whether, at its junction with the primary ſtrata, it ſeems to be in part intermixed, and partly aſſuming the nature of theſe ſtrata; thus intimating that they have been depoſited at the ſame time.

The

The micaceous ſhiſtus extends quite acroſs this part of the iſland; and continues for about a mile after we leave Buneſan, in going to the ſouthern extremity of the iſland. In this extent it is ſomewhat varied in its appearance, being more or leſs compact, ſometimes containing garnets, and traverſed with baſaltic veins. In other places, as upon the ſide of Loch-Artineg, I obſerved it alternating with ſtrata of quartz, from one to three feet thick, and which broke into thin layers.

To the micaceous ſhiſtus ſucceeds beautiful red granite, which continues to the extremity of the iſland, forming low, round-ſhaped hills. This part of the iſland, which is called Roſs, is low, interſected with ſmall lakes, and diverſified with natural wood. The ſhores are low, but rugged and broken; and in ſome places we obſerved large empty fiſſures, which appear to have been formerly filled, either with an earthy matter, as baſalt, or with a metallic ore. The granite appears to be diſpoſed in beds, as we have already mentioned to be the caſe in Arran. Dr Walker, many years ago, obſerved this diſpoſition of the granite, not only in Mull, but in many other parts of Scotland; which is a further and deciſive proof of the fallacy of La Metherie's obſervations. The granite ſometimes ſplits into rhombs, and what is more uncommon, into columns, not unlike baſalt. This appearance of columnar granite is,

I believe, rather a rare occurrence; at leaſt I do not find it mentioned but by Reuſs, who diſcovered beds of granite ſplit into columns, not unlike baſalt *. In many places I obſerved baſaltic veins traverſing the granite; and theſe are of various ſizes, and run in very different directions. Upon the ſide of Loch-Artineg I obſerved a vein running through the granite, viſible for nearly a mile, and often branching out in different directions. Sometimes I obſerved pieces of granite included in the baſalt veins; and in one inſtance I obſerved the granite, which bounds the ſide of the vein, mixed with the baſalt.

The ſouth ſide of Roſs continues to be formed of granite and micaceous ſhiſtus, until we come upon a line with Buneſan, when the baſaltic rock commences. From this to Loch-Buy the country and coaſt are principally formed of baſalt and wacken, excepting at Gribun, where ſandſtone and limeſtone are to be obſerved, and at Carſeg, where there are conſiderable appearances of limeſtone. The rocks upon this coaſt, in ſome places, riſe to a moſt tremendous height, particularly at Innimore, where we obſerve many ranges of baſaltic columns towering

* Mineralogiſche Geographie von Boehmen, Erſter band, § 120. I think that Sauſſure, ſomewhere in his Travels, mentions a ſimilar appearance.

towering above each other with vaſt magnificence. This ſtupendous ſcene is rendered doubly intereſting when its rocks are obſcured by a tempeſt: the daſhing of the furious ocean below, and the fall of vaſt caſcades from the rugged ſummits, ſeen dimly thro' the clouds, preſent a ſcene of uncommon ſublimity.

There are ſeveral appearances of coal upon this coaſt, but the moſt remarkable is that upon the hill called Beinan-ini. This hill is compoſed of horizontal ſtrata of baſalt and wacken, which alternate, and riſe to the top of the hill like great natural terraces. The coal appears in the bed of a rivulet upon the ſide of the mountain; is about three feet thick, and is immediately covered by baſalt. It is one of the greateſt ſtrata of coal that has yet been diſcovered in the Weſtern Iſlands, and conſequently is worthy of particular attention. Several trials have been made with a view to the working of it; but of a nature ſo trifling, that they can deſerve notice only as ſhowing how little the importance of the ſubject has been underſtood. Sir David Murray of Stanhope, ſo far as we can learn, was the firſt gentleman who ſeems to have been aware of its conſequence; for, about the beginning of the laſt century, he purchaſed this hill ſolely on account of the coal which it contains. He propoſed to open the ſtratum in a very extenſive manner,

and

and to work it until he ſhould be ſatisfied whether it was practicable to continue it to advantage. This ſcheme was unfortunately fruſtrated by a failure in his affairs, which made him ſtop working a ſhort time after he had begun. Since that period, the property has come into the poſſeſſion of Sir James Riddell of Ardnamurchan, who ſeemed inclined to continue the work of his predeceſſor; but the buſineſs appears to have been committed to perſons who were ſatisfied with making very ſuperficial and unſatisfactory trials. This is much to be regretted, when we conſider, that the eſtabliſhment of coal-works, in ſo centrical a ſpot of the Hebrides, would not only be a great comfort to the inhabitants of the iſlands, where peat is ſcanty, and not to be procured without difficulty, but would make all the operations of the farmer to go on with new life, and would, in every way, contribute much to the improvement of the Weſtern Iſlands. It is therefore worthy of the public ſpirit of the highland proprietors, to form a general ſubſcription, ſo as to enable them to determine the queſtion, whether the coal of Mull can be worked ſo as to be advantageous to the inhabitants of the weſt coaſt of Scotland and the Hebrides.

Having ſpent a few days in Roſs, which gave us an opportunity of examining I-colum-kill, we walked again to Loch-

Skriddan,

Skriddan, where we took a boat, and rowed along the lofty coaſt to Luggan-Ulva. In our way we paſſed the ſmall iſland of Inch-Kenneth, remarkable not for its variety of foſſils, as it is compoſed of red-coloured ſandſtone and limeſtone? but for the intereſting account which Dr Johnſon has given of the happy family of Sir Allan Maclean.

We now walked from Luggan-Ulva to Torloiſk, the ſeat of the late worthy Mr Maclean. The ſhore is rugged; but the country is in ſeveral places conſiderably cultivated, particularly near Torloiſk. The rocks, all the way, are of baſalt and wacken; and both contain beautiful ſpecimens of zeolite, which are generally fibrous, and ſometimes appear paſſing to chalcedony. I obſerved, in ſome places, a red-coloured wacken alternating with the baſalt. I alſo remarked blocks of granite ſimilar to that we obſerved at Arros.

From Torloiſk to the northern extremity of the iſland, the ſame baſaltic rock continues; and, ſo far as I could judge, the whole of the coaſt towards Tobermory is of the ſame nature.

GENERAL

General Observation. From this rapid and imperfect outline, it appears, that a great portion of this iſland is compoſed of rocks of trap formation, and that they even form many of the high hills. The primary ſtrata, upon the other hand, form a very ſmall part; being confined (as far as my experience goes) to the pariſh of Roſs, and the ſmall patch upon the ſhore between Luggan-Ulva and Loch-Skriddan.

MULL.

M U L L.

C H A P. XIV.

Defcription of the Fossils *mentioned in the preceding Chapter.*

IT may appear unneceffary again to introduce an account of the ardefia tegularis, as I have defcribed it in Arran and Jura. The defcription which now follows, however, is that of one of the moft celebrated flates in Britain, and therefore it fhould not be omitted.

ARDESIA TEGULARIS—*from Eafdale.*

Colour. Dark blue.
Luftre. Little fhining.
Tranfparency. None.
Fracture. Perfectly flaty.

Fragments. Tabular.

Hardneſs. Yields pretty eaſily to the knife.

Streak. Of a lighter colour than the ſlate itſelf; and the powder does not feel greaſy.

Adheſion. Does not adhere to the tongue.

Smell. Pretty ſtrong earthy ſmell when breathed on.

This ſpecies differs from that of Bute, in containing leſs magneſia, and being more durable. It frequently alſo contains cubical cryſtals of pyrites, and theſe long reſiſt decompoſition.

GRAUWACKE, German—*Iſland of Seil.*

Rubble Stone, Kirwan's Mineralogy.

This ſpecies is compoſed of fragments of ardeſia and quartz, with ſcales of mica, or talc, connected by a reddiſh argillaceous matter. This genus of rock was for ſome time imagined to be peculiar to the Hartz (the great mining country belonging to the Elector of Hanover), but later inveſtigators have obſerved it in other parts of the continent of Europe. We have much information concerning it in Lazius's obſervations upon the Hartz.

LIME-

LIMESTONE—*Achnacraig.*

Colour. Dark blue.

Luſtre. A degree of luſtre owing to diſperſed foliæ.

Tranſparency. None.

Hardneſs. Difficultly ſcraped with the knife.

Fracture. Earthy; ſometimes approaching ſplintery.

Has pyrites diſperſed thro' it; and ſometimes I diſcovered it to contain Belemnites. By decompoſition it acquires a yellowiſh colour, and this is much aided by the preſence of the iron pyrites.

GREENSTONE?—*Achnacroſh.*

Colour. Whitiſh, from the great proportion of felſpar?

Luſtre. None.

Tranſparency. None.

Hardneſs. Gives fire pretty freely with ſteel.

Fracture. Earthy.

This rock appears to confiſt principally of a whitiſh-coloured matter, which is probably of the nature of compact felſpar; and, intermixed with it, I diſcovered ſmall portions of a green-coloured ſubſtance reſembling hornblende, with a few interſperſed cryſtals of common felſpar and iron pyrites. It acquires a browniſh-white tegmen by decompoſition.

GREENSTONE—*Hill near Achnacraig.*

Grunstein, German. *Saxum Ferreum*, Waller. *Saxum Grandævum*, Linn.

The greenſtone found upon this hill is compoſed uſually of equal portions of white-coloured felſpar and dark-green hornblende. I alſo obſerved ſpecimens where the hornblende forms the greater part of the ſtone, and the felſpar imbedded in it as a baſis. In others, the felſpar and hornblende are ſo intimately combined together, that it is only by the decompoſition of the ſtone that we diſcover its compound nature.

HORN-

HORNSTONE—*Hill near Achnacraig.*

Colour. Brown.

Luſtre. None.

Tranſparency. Tranſmits a little light at the edges.

Fracture. Fine ſplintery.

Hardneſs. Gives ſparks freely with ſteel.

By decompoſition it takes a cream colour, and an earthy fracture; and, in this ſtate, the diffuſed particles of quartz are rendered more diſtinct, from their longer reſiſting the influence of the weather.

EARTHY FELSPAR.

Continuous Felspar, Angl. *Felspar en masse*, Dolomieu. *Petrosilex*, Journ. de Phyſ. New Series, vol i. La Mether. Theorie de la Terre.

Colour. Brick red.

Luſtre. None.

Fracture. Earthy.

Trans-

Tranſparency. None.

Hardneſs. Give ſparks freely with ſteel.

Dolomieu, in a paper publiſhed in the Journal de Phyſique *, endeavours to prove that this foſſil is diſtinct from felſpar, and, after a long chain of obſervation, he concludes by naming it Petroſilex. La Metherie, who ſeems of the ſame opinion, denominates the true hornſtone of the Germans Keratite, and agrees with Dolomieu in applying the term Petroſilex to this foſſil ‡. I am, however, ſtill inclined to think, that it will be more correct to uſe the terms hornſtone and petroſilex in the ſignification as adopted by Werner; and that the petroſilex of Dolomieu is to be conſidered as a ſpecies of felſpar; or, if it be truly diſtinct from every other foſſil, that it ſhould be diſtinguiſhed by a name that has no reference to one already in uſe. Dolomieu always refers it to the rocks of primary formation; yet this is not quite correct; for Reuſs † mentions a ſpecies of porphyry, with a baſis of earthy felſpar, reſting on ſandſtone.

LIME-

* Vol. i. New Series.

‡ Theorie de la Terre, tom. ii. p. 173.

† Reuſs, Aufzatze, § 388. Mineralogiſche von Boehmen, B. ii. § 124.

LIMESTONE—*between Loch-na-gaul and Loch-Skriddan.*

Colour. Yellowifh.

Luftre. None.

Tranfparency. None.

Fracture. Fine fplintery.

Hardnefs. Scarcely yields to the knife, and fometimes ftrikes fire with flint.

Contains, fometimes, cryftallized rhomboidal calcareous fpar; alfo difperfed particles of quartz; which are frequently fo plentifully intermixed, as to increafe the hardnefs very much. But the moft remarkable intermixed fubftance is flint and hornftone.

The flint has the following characters:

Colour. Greyifh black.

Luftre. Like that of common flint.

Tranfparency. Tranfmits light pretty freely, but objects cannot be difcerned.

Fracture.

Fracture. Conchoidal; ſometimes multiplied conchoidal.

Hardneſs. Gives ſparks plentifully with ſteel.

It has immerſed in it particles of quartz ſimilar to thoſe we obſerve in the limeſtone; and alſo intermixed is the hornſtone, which has the following characters:

Colour. Light blue.

Luſtre. None.

Tranſparency. Allows light to paſs at the edges.

Fracture. Nearly even.

Hardneſs. Gives a few ſparks with ſteel.

It has alſo, interſperſed, calcareous ſpar and quartz. By action of the weather, it becomes opaque and white; and the quartz and calcareous ſpar falling out, cauſes the hornſtone to have a cellular appearance. Not unoften we obſerve the hornſtone paſſing to flint, and *vice verſa.*

Dr Walker, in his mineralogical lectures, informs us, that, although he has travelled over a conſiderable extent of Scotland, he has ſeldom obſerved any appearance of flint. This warrants us to conclude that it is a rare production in Scotland.

land. Similar limeſtone rocks, containing flint, occur in the north of Ireland, in Switzerland ‡, and my friend Mr Deriabin informs me that he obſerved a rock reſembling that of Mull in Tranſylvania.

GRANITE—*from Roſs, in Mull.*

This granite, which forms the coaſt of Roſs, in Mull, is compoſed of beautiful fleſh-coloured felſpar, white quartz, and black mica. Sometimes the granite is very ſmall-grained, with a great proportion of black mica, which gives it a blackiſh colour; or we obſerve it where the felſpar is in the greateſt proportion, when it has a fine uniform red colour. Rarely we obſerve whitiſh-coloured cryſtals of felſpar, and ſteatites; which laſt, according to the obſervations of Werner, is formed by the decompoſition of the mica.

‡ Helv. Mag. 116.

BASALT—*Torloisk*, *Luggan-Ulva*, &c.

Colour. Black.

Lustre. Slight degree, from a number of very minute, shining particles.

Fracture. Even, passing to conchoidal.

Hardness. Gives a few sparks with steel.

Streak. Grey.

The weather seems to have very little effect upon it, excepting when it contains iron pyrites. It frequently contains zeolite, which is generally radiated; and is sometimes to be observed passing, by imperceptible gradations, to fine milk-coloured chalcedony. As the late Mr. Pelletier of Paris has shown that zeolite contains potash, and as it here passes to chalcedony, it is not improbable that some species of chalcedony may afford alkali.

WACKEN,

WACKEN, highly impregnated with Iron—*Torloisk.*

Colour. Tile or copper red.

Lustre and Transparency. None.

Fracture. Even.

Hardness. Yields with considerable difficulty to the knife.

Is very heavy, and emits an earthy smell when breathed upon. I observed it passing into common-wacken.

ON COAL.

CHAP. XV.

Method of discovering COAL.

AFTER the defcription which I have given of the different appearances of coal in the ifland of Mull, I intended to have added a fhort account of the method to be followed in difcovering coal ftrata or veins; but I found that this would be more diftinct if detailed in a feparate chapter. I fhall now, therefore, ftate the obfervations.

If a certain extent of country is fuppofed to contain coal, we fhould begin our examination by determining the extent of the primary ftrata; which will confiderably abridge our labour, as thefe ftrata never contain coal.

We

We ſhould next examine the nature, direction, dip, and relative extent of the different ſecondary ſtrata; which will give us an opportunity of diſcovering any appearances that indicate the preſence of coal. Theſe particular places are to be examined with the moſt ſcrupulous accuracy; and the coal ſtrata to be ſought for by digging, or boring, according to the nature of circumſtances.

Such is the general mode of proceeding in theſe reſearches. I ſhall now mention, particularly, the rocks which are indicative of coal; then the method of determining whether coal ſtrata do exiſt in a certain ſituation—firſt, as determined by the appearance of fragments of coal, and, ſecondly, by boring, where no actual appearance of coal is diſcovered.

The principal rocks, which are mentioned by mineralogiſts as indicative of coal, are the following:

1. White argillaceous ſandſtone. If this ſandſtone has, interſperſed, bituminous or carbonaceous matter, it is reckoned a good ſymptom of the vicinity of coal.

2. If

2. If bituminous ſhale, ſhiſtoſe clay and argillaceous iron-ſtone are obſerved, it is a further, and a very favourable ſymptom of coal.

3. If ſandſtone and limeſtone alternate, and be accompanied with bituminous ſhale, it is reckoned favourable for coal.

4. Sometimes where ſandſtone and baſalt alternate, coal has been found.

5. Mr Kirwan remarks that there is great probability of finding coal in the neighbourhood of mountains of argillaceous porphyry †.

6. Although coal has never been obſerved alternating with primary ſtrata, yet it has ſometimes been found in their immediate vicinity ; and coal has even been obſerved lying on granite. I believe, however, that ſuch coal ſtrata are generally trifling.

Having

† Geological Eſſays, p. 347.

Having, from an accurate inveſtigation, diſcovered ſuch ſtrata as render the preſence of coal probable; we muſt next endeavour to diſcover its actual exiſtence. To do this, we muſt examine the beds and banks of rivulets, where, if ſmall pieces of coal appear, we may be pretty certain that coal ſtrata exiſt near at hand. Ditches are to be examined; for, in forming them, it is often neceſſary to cut thro' the thin covering of gravel and ſand which conceals the crop from our view. We ſometimes obſerve a ſooty-like matter ſpread on the ground: this is formed from the decompoſition of coal, and is therefore a good ſymptom of its vicinity. Not unfrequently we obſerve maſſes of coal, or bituminous wood, immerſed in the breccia which is obſerved in coal countries: but this is often a fallacious appearance; for, upon cutting thro' the breccia, we find that the ſubjacent rocks contain no coal; ſo that the pieces of coal or wood, which the breccia contains, are to be conſidered as merely accidental.

After having obſerved any of the above-mentioned appearances; our next endeavour is to obſerve the crop, or the outburſt, of the ſtrata. This is a matter of much difficulty; and requires particular attention to the diſpoſition of the fragments of coal, &c. If they be found upon the banks or bed of a rivulet,

vulet, we muſt ſearch from one extremity of the ravine to the other, to diſcover the crop of the ſtratum. If the ſoot-like matter is obſerved, it will be neceſſary to remark whether it lies upon a declivity or a plain; as inattention to theſe circumſtances has often been the cauſe of great diſappointment and expence to the coal-miner in overſhooting the ſtratum, that is, cutting beyond its real ſituation. Upon a declivity, we know that the decompoſing and looſe matter of a crop will naturally ſpread downwards, in proportion to the ſteepneſs of the ground. On this account, wherever appearances of coal occur upon a declivity, we muſt trace the debris upwards; when we ſhall find it increaſe in depth towards the crop, and the coal is leſs and leſs decompoſed as we approach nearer to it. On the other hand, where the ſooty matter occurs upon a plain, we always find it thicker, and far leſs ſpread, than upon a declivity; and, what is of conſequence, it often ſpreads in a direction contrary to the riſe of the ſtrata. If we are ſo lucky as to obſerve the crop, we now endeavour to detect the ſtratum; which we do, either by digging towards its dip, or by following the fragments of coal until we have the ſtratum fairly under our eye.

It

It often happens, however, that a country may be, in general, very favourable for coal, yet no pieces of coal or footy matter are to be obferved, owing to the coal ftrata lying deep: in fuch cafes a good deal of difcernment is neceffary to determine the particular places where the trials are to be made. As it would be very expenfive, in fuch cafes, to dig down until we fhould meet with the coal, the common practice is to bore the ground; by which, at a fmall expence, we can know the magnitude and nature of the ftrata, to a great depth.

In fearching for coal, by boring, our firft object is, to determine the point to which the ftrata rife; as it is this which enables us to determine at what place we fhall begin to bore. The plan, at the end of this chapter, will fufficiently explain the mode of proceeding in this operation. Suppofe A B C D to reprefent a tract of country which is fufpected to contain coal, and where the rife of the ftrata is towards A. We there make the firft perforation, which will pafs thro' the ftrata 4, 3, 2, 1, to the depth of ten or twelve fathoms. If no coal occurs among thefe ftrata, it is better to make a new perforation, than to fink deeper. We therefore proceed onwards to B, where we fufpect that the ftratum 5 is ten or twelve fathoms deep. We here bore through the ftrata, 8, 7, 6, to 5;

H h and,

and, as no coal occurs, we do not bore deeper, but proceed to the point C, where we make a perforation through the ſtrata 11, 10, 9, to 8. By being ſtill unſucceſsful, we proceed onwards to D, where the ſtratum 11 will be about ten or twelve fathoms deep, and here we find coal at 12.—By this practice, it is plain that that no ſtratum of coal can eſcape notice, as the laſt perforation always reaches down to the ſtratum which was neareſt to the ſurface in the former bore.

Having diſcovered the breadth of the ſtratum, either by digging, when it is near the ſurface, or by boring, when it is covered by a great load of other ſtrata; our next concern is, to determine whether it be of ſufficient importance to be worked. If it is not more than 15 inches in breadth, even altho' pretty near the ſurface, it is not worth working; but if it be two feet, or two feet and a half wide, and of good quality, it can be worked in moſt ſituations with advantage.

The quality of the coal is aſcertained from the following circumſtances:

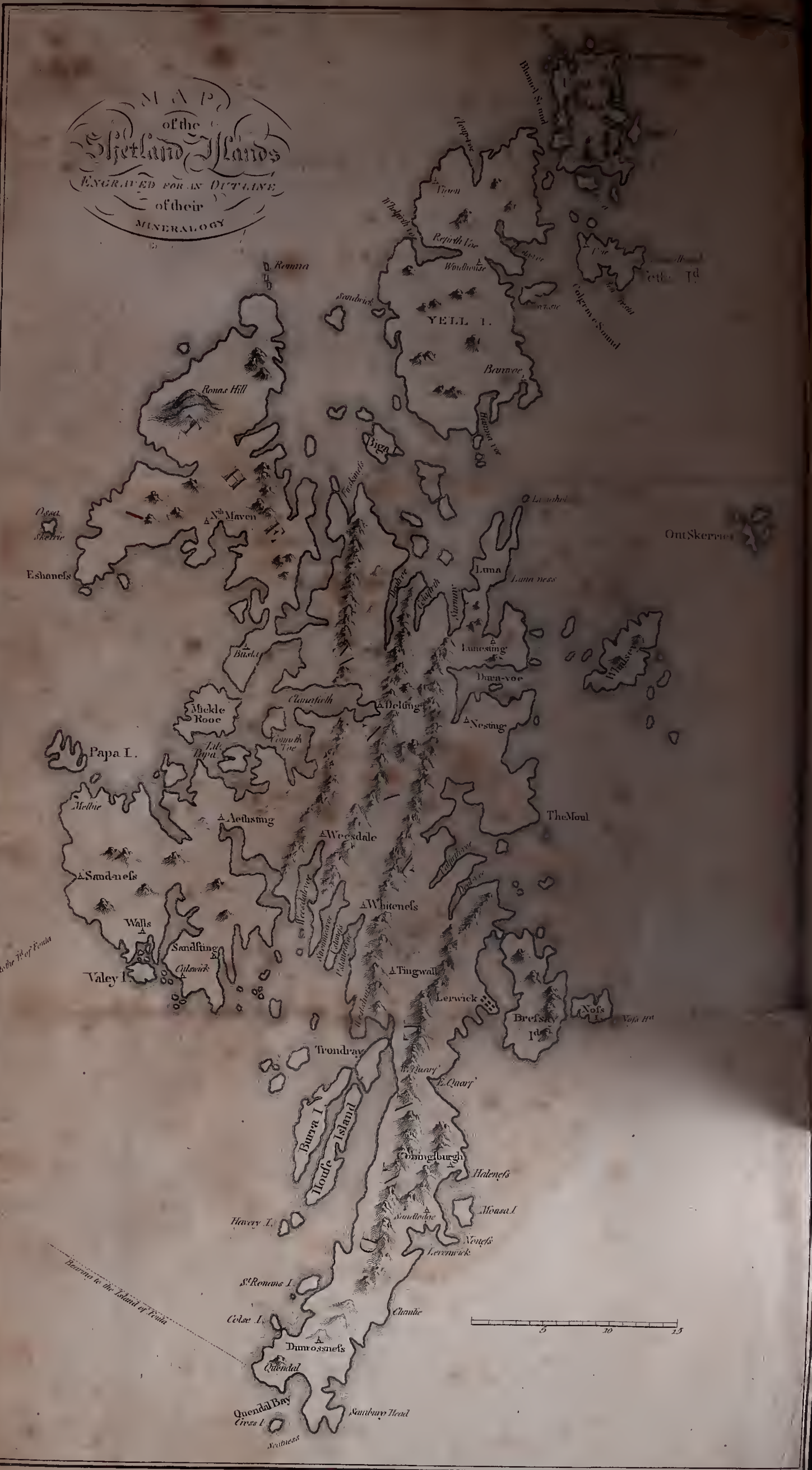
1. Its general appearance: whether it be more or leſs mixed with ſtoney matter; or if there be laminæ of bituminous ſhale or

or sandstone, dividing it into stratulæ; or if it contains much pyrites or sulphuret of iron.

2. To these may be added the test of chemical analysis, by which we ascertain the proportion of carbon, bitumen and ashes.

Plan illustrating the method of boring for Coal

END OF VOLUME FIRST.


MAP
of the
Shetland Islands
ENGRAVED FOR AN OUTLINE
of their
MINERALOGY
Ronas Hill
N.th Maven
Eshaness
Ossa Skerrie
YELL I.
Refirth Voe
Woodhouse
Burravoe
Sandwick
Biga
Luna
Luna ness
Lunesting
Dura-voe
Nesting
Whalsey
Out Skerries
Busta
Mickle Rooe
Clousta
Papa I.
Lit. Papa
Melbie
Aethsting
Weesdale
Sand-ness
Walls
Sandsting
Culswick
Valey I.
Whiteness
Tingwall
Lerwick
The Moul
Bressay Id.
Noss I.
Noss Hd.
Trondray
Burra I.
House Island
W. Quarf
E. Quarf
Conningburgh
Haleness
Moasa I.
Sandlodge
Noness
Levenwick
Havery I.
St. Romans I.
Colse I.
Clumlie
Dunrossness
Quendal
Quendal Bay
Cross I.
Sumburgh Head
Scatness
Bearing to the Island of Foula
to the Id. of Foula
5
10
15

MINERALOGICAL TRAVELS

THROUGH THE

HEBRIDES, ORKNEY AND SHETLAND ISLANDS,

AND

MAINLAND OF SCOTLAND,

WITH

DISSERTATIONS UPON PEAT AND KELP.

IN TWO VOLUMES,

ILLUSTRATED WITH MAPS AND PLATES.

BY ROBERT JAMESON,

REGIUS PROFESSOR OF NATURAL HISTORY AND KEEPER OF THE MUSEUM, AND LECTURER ON MINERALOGY IN THE UNIVERSITY OF EDINBURGH, PRESIDENT OF THE WERNERIAN SOCIETY, FELLOW OF THE ROYAL SOCIETY OF EDINBURGH, AND OF THE LINNEAN SOCIETY OF LONDON, HONORARY MEMBER OF THE ROYAL IRISH ACADEMY, OF THE HONOURABLE DUBLIN SOCIETY, OF THE GEOLOGICAL SOCIETY OF LONDON, OF THE PHYSICAL AND MINERALOGICAL SOCIETIES OF JENA, *&c.*

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MINERALOGY

OF THE

SCOTTISH ISLES.

VOLUME II.

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CHAP. XVI.

Outline of the MINERALOGY *of* I-COLUMB-KILL *and* STAFFA.

I-COLUMB-KILL.

THIS iſland is mentioned by writers under the different names of Hii, Iona, and I-columb-kill; but it is now generally denominated by the inhabitants I, or I-columb-kill: the

latter name being derived from St. Columba, the tutelary ſaint of the Hebrides. It is about three miles long, and from half a mile to a mile and a half in breadth. It is low, (yet not without hills, of which Dun-ii is the higheſt,) bare and rugged, excepting in the neighbourhood of the religious houſes, where the ground is flat and cultivated, yielding about 140 l. per annum, which is nearly the rent of the whole iſland. The ſhores are in general low and rocky, yet in a few places there are pretty high cliffs.

History. The early hiſtory of this iſland is involved in the general obſcurity which veils the ancient hiſtory of Scotland; ſo that the many traditional tales concerning it, which have reached our times, are not worthy of ſerious attention. The moſt ancient written records that concern it, are not earlier than the æra of the landing of St. Columba. This remarkable man left Ireland, his native country, not, as Mr Pennant remarks, from diſcontent, but with the noble and generous intention of diſſipating the ignorance which then covered the Hebrides. He landed finally upon I, where he built religious houſes; and the iſland was ſoon afterwards preſented to him by Connal king of Scotland. Having contributed much to the diffuſion of Chriſtianity through the wilds of the Hebrides, and other parts of Scotland, he died, at the age of ſeventy-ſeven,

ven. He was certainly a man of much piety and goodnefs of heart; and his manners, altho' extremely auftere, were well calculated for the people of the age in which he lived. For two hundred years after his death, the religious of this ifle lived quietly, and in the high eftimation of all the country. About the year 716, the ferocious Danes, who had haraffed every part of Scotland with their barbarous invafions, at length difturbed this feat of religion and learning; maffacred the greater part of the monks, and drove the remainder from the ifland. Some time afterwards the whole of the Weftern Iflands were fubjugated to the regular Danifh government, when many of the monks again returned to I. From this period, however, the college of I gradually declined, until the twelfth century, when the Romifh priefts having got poffeffion of all the monafteries, the Culdees, or fect of St. Columba, were difperfed, and gradually funk from notice, leaving behind them a high reputation for learning and virtue.

Mineralogy. At the ufual landing place, from Rofs in Mull, the fhore is rugged, and formed of a rock which appears to be compofed of quartz pretty intimately combined with chlorite, and hornblende. It is, however, fubject to much variety; for it is obferved paffing on the one hand to hornblende

rock, and ardesia; and on the other, into a siliceous talcaceous shistus *. It is traversed with veins of the granites garbenbergensis of Linnæus, a rock which is composed of quartz and mica. As we proceeded on towards the N. end of the island, we examined the venerable ruins of the Cathedral, and other houses, which were formerly the residence of the religious of the North; "whence savage clans, and roving barbarians, "derived the benefits of knowledge and the blessings of religi-"on." The description of these buildings, would be interesting to the antiquary; but it is an object unconnected with my present pursuit; and besides, they have been illustrated by the descriptions and drawings of Mr Pennant, and Dr Garnet. I regret much, however, that I am prevented from communicating to the public, the elegant and truly characteristic drawings made by my friend Mr Bell: they are the only ones I have ever seen that convey a complete idea of these remarkable ruins.

The strata which we observed at the landing place, continue to the N. E. extremity of the island, when they give place to hornblende slate, sienite, and hornblende rock having much the

* Mr. Mills says, that the rock at the landing place is laminated hornstone. Philosophical Transactions of the Royal Society of London, 1790, p. 77.

the appearance of ferpentine. Thefe rocks alternate with each other, and are to be obferved traverfed by bafalt and granite veins. From this to Dun-ii, the higheft hill in the ifland, the hornblende and fienite ftrata, continue forming, upon fome parts of the coaft, cliffs of confiderable height. We afcended to the fummit of this hill, which I found to be compofed of primitive rock; and principally of hornblende flate. As we walked onwards, by the weft fide, to the fouthern extremity of the ifland, we faw upon the coaft feveral fandy beaches and fteep cliffs; and the ftrata continued to Porta-curach, to be hornblende flate, and fienite, traverfed with bafalt and granite veins. We obferved at a diftance, two fhelving rocks of a green colour; which are probably of the nature of ferpentine, or hornblende. At Porta-curach, or St. Columba's landing place, there are cliffs of confiderable height, which are compofed of ftrata of hornblende rock, having much the appearance of ferpentine, and fienite. Thefe ftrata are traverfed with veins of granite, and veins of quartz, (which have a light fifkin-green colour, owing to its admixture with hornblende,) are alfo to be obferved. The beach is covered with numberlefs rounded fragments of marble, quartz, of an amethyftine hue, fifkin-green-coloured quartz, and lapis nephriticus. We now walked acrofs this ifland, over the ufual hornblende and other rocks, to the marble quarry. This marble,

or

or what is now called dolomite, forms a great ſtratum about 40 feet wide, running N. N. W. and S. S. E. and bounded by nearly vertical ſtrata of a rock which is in ſome parts of the nature of ſhiſtoſe talc or paſſing to chlorite ſlate *. The marble as it approaches the other ſtrata, is more or leſs mixed with talc, which cauſes it to become ſcaly or fibrous, with a yellowiſh green colour; thus approaching to the nature of talcaceous ſhiſtus. I often alſo obſerved maſſes of nephrite, and of fine green talcaceous ſhiſtus, immerſed in the marble; the nephrite appears to have been formed at the ſame time with the marble, as I obſerved it diſſeminated and combined with it in a ſimilar manner as the hornblende in the ſiskin-green quartz; the talcaceous ſhiſtus, however, is diſperſed in large irregular maſſes that ſeem to have been broken off from the neighbouring ſtrata. From the marble quarry to the landing place, the ſhore is bare and rugged; and the ſtrata do not differ from thoſe we have already deſcribed. At a little diſtance from it, we obſerved ſeveral iſlands and rocks, entirely compoſed of red granite: thus rendering it probable, that this iſland was formerly joined with the granite coaſt of Roſs, in Mull.

Dr.

* Upon one ſide of the ſtratum, I obſerved a layer of felſpar; which is intermixed with quartz, paſſing to hornſtone.

Dr. Garnet, in his lately publiſhed tour through the Highlands, remarks, that the greater part of this iſland is formed of limeſtone; and that the ſtrata are all of ſecondary formation. The firſt obſervation, as far as my experience goes, is incorrect; for after having walked around a conſiderable part of the iſland, I only found marble in one place; and was informed, that it had been obſerved in another ſpot. The other obſervation is contradicted by the account I have juſt given of the ſtrata of the iſland.

STAFFA.

AS I had not an opportunity of landing upon this remarkable iſland, I am prevented from giving any deſcription of the rocks of which it is compoſed, from my own obſervations; I will, therefore, give a ſhort account of it drawn from the accounts of others; which I have confirmed and corrected by ſpecimens brought from the iſland.

The

This iſle is about one mile long, and half a mile broad, and nearly two miles in circumference. It is not very high; the higheſt part, which is that immediately above Fingal's cave, being about 114 feet above the level of the ſea. Its coaſt is ſteep, and bounded by magnificent baſaltic colonades; which are in ſeveral places broken into caves; and of theſe, the moſt remarkable is that called Fingal's cave. It is not above 25 years ſince the wonders of this little ſpot were made known to philoſophical enquirers, by Sir Joſeph Banks, who communicated his elegant drawings and deſcription, to the late Mr. Pennant. This will not appear ſurpriſing, if we conſider that thoſe, who are accuſtomed to travel frequently among the Hebrides, become ſo much accuſtomed to the appearance of baſaltic colonades, that it requires ſomething very extraordinary to excite their curioſity. Staffa, even at no great diſtance, has a more diminutive appearance, than other baſaltic rocks, which are by no means ſo magnificent; and probably, from this circumſtance, it long eſcaped the attention even of the gentlemen of this neighbourhood. The emotions excited by the view of this magnificent ſcene, are thus expreſſed by the learned Preſident of the Royal Society: "At nine o'clock, (ſays he,) after "a tedious paſſage, having had not a breath of wind, we ar-"rived, under the direction of Mr. Maclean's ſon, and Mr. "Leach. It was too dark to ſee any thing, ſo we carried our tent

" tent and baggage near the only houfe upon the ifland, and
" began to cook our fupper, in order to be prepared for the
" earlieft dawn, to enjoy that which, from the converfation of
" the gentlemen, we had now raifed the higheft expectations of.
" The impatience which every body felt to fee the wonders we
" had heard fo largely defcribed, prevented our morning reft;
" every one was up and in motion before the break of day;
" and with the firft light arrived at the fouth-weft part of the
" ifland, the feat of the moft remarkable pillars, where we
" no fooner arrived, than we were ftruck with a fcene of mag-
" nificence which exceeded our expectations; though formed,
" as we thought, upon the moft fanguine foundations; the
" whole of that end of the ifland, fupported by ranges of na-
" tural pillars, moftly above fifty feet high, ftanding in natural
" colonnades, according as the bays or points of land formed
" themfelves; upon a firm bafis of folid unformed rock, above
" thefe, the ftratum which reaches to the furface or foil of the
" ifland, varied in thicknefs, as the ifland itfelf formed into
" hills or vallies; each hill, which hung over the columns be-
" low, forming an ample pediment; fome of thefe above 60
" feet in thicknefs, from the bafis to the point, formed by the
" floping of the hill on each fide, almoft into the fhape of thofe
" ufed in architecture. Compared to this, what are the cathe-
" drals or the palaces built by men: mere models or play

" things ; imitations as diminutive as his works will always be
" when compared to thofe of nature. Where is now the boaft
" of the architect ! regularity, the only part in which he fan-
" cied himfelf to exceed his miftrefs, nature, is here found
" in her poffeffion ; and here, it has been for ages undefcrib-
" ed. Is not this the fchool where the art has been originally
" ftudied ; and what has been added to this by the whole Gre-
" cian fchool ? a capital to ornament the column of nature,
" of which they could execute only a model ; and for that very
" capital, they were obliged to a bufh of acanthus : how am-
" ply does nature repay thofe who ftudy her wonderful works !
" With our minds full of fuch reflections, we proceeded along
" the fhore, trading upon another Giants caufeway ; every ftone
" being regularly formed into a certain number of fides and
" angles ; till in a fhort time, we arrived at the mouth of a
" cave, the moft magnificent, I fuppofe, that has ever been
" defcribed by travellers.

" The mind can hardly form an idea more magnificent than
" fuch a fpace, fupported on each fide by ranges of columns,
" and roofed by the bottoms of thofe which have been broke
" off in order to form it : between the angles of which, a yel-
" lowifh ftalagmitical matter has iffued, and ferves to define
" the angles precifely ; and at the fame time, vary the colour
" with

" with a great deal of elegance; and to render it ſtill more " agreeable, the whole is lighted from without; ſo that, the " fartheſt extremity, is very plainly ſeen from without; and " the air within, being agitated by the flux and reflux of " the tides, is perfectly dry and wholeſome; free entirely " from the damp vapours, with which, in general, natural ca- " verns abound." The learned Biſhop of Linkoeping, remarks, " how ſplendid do the porticos of the ancients appear " in our eyes, from the oſtentatious magnificence of the deſ- " cription we have received of them; and with what admira- " tion are we ſeized, on ſeeing even the colonades of our mo- " dern edifices! But when we behold the cave of Fingal, for- " med by nature in the iſland of Staffa, it is no longer poſſible " to make a compariſon; and we are forced to acknowledge, " that this piece of architecture, executed by nature, far ſur- " paſſes that of the Louvre; that of St. Peter's at Rome; and " even what remains of Palmyra and Paeſtum; and all that the " genius, the taſte, and the luxury of the Greeks, were ever ca- " pable of inventing."

Such were the very ſtrong impreſſions which the columnar rocks of Staffa made on the learned gentlemen who firſt explored them; and we are not to be ſurprized, that the contemplation of ſcenery ſo new and ſtriking, ſhould have raiſed in their

minds a picture, which to other travellers may seem over-coloured. Although I had not an opportunity of landing on the island, yet from what I saw, and have frequently been told, I do not in the least doubt that the ruins of Palmyra, or the vast remains of Egyptian architecture, would more powerfully interest the feelings, than all the wonders of Staffa. But this is mere matter of opinion; I will therefore pass to the account of its mineralogy.

From all the accounts which have been published, and the specimens which I have examined, the island seems to be principally formed of basalt and wacken. The basalt is generally in the form of columns, which are, 1. Triangular: of this form, there are specimens in the museum of the University. 2. Quadrangular. 3. Pentagonal. 4. Hexagonal. 5. Heptagonal. 6. Octogonal. 7. Articulated like the Giants causeway or those of the beautiful columns at Dunbar harbour. 8. Jointed without the convex or concave extremities. These pillars generally rest upon a basalt tuff or breccia *, and the strata of basalt columns (as is the case in other parts of Scotland,) follow the more or less inclined direction of the tuff or breccia. The colonades are usually covered

* Faujas' Travels, vol. 2. p. 58. 59. He there names the basalt tuff, gravelly lava.

covered by a thick ſtratum of baſalt, which has ſometimes an irregular columnar ſhape. Mr. St. Fond alſo mentions, that he obſerved cubical zeolite, octogonal ſemitranſparent zeolite: white ſemitranſparent zeolite, in cryſtals of thirty facettes: this is probably leucit: and alſo zeolite paſſing to chalcedony.

Both Mr St Fond, and Mr Mills, inform us, that they found granite among the rolled ſtones upon the ſhore of the iſland. Theſe are either derived from the baſalt tuff, or they have been conveyed by currents from the neighbouring granite coaſt of Roſs: but the firſt ſuppoſition ſeems the moſt probable.

I-CO-

I-COLUMB-KILL.

CHAP. XVII.

Defcription of the Fossils *mentioned in the preceding Chapter.*

Sifkin-green coloured QUARTZ of *I-columb-kill.*

The quartz which forms a part of the fienite, and hornblende rock of I-columb-kill, has often a white or bluifh colour, with the ufual luftre, tranfparency, fracture, and hardnefs; but it is alfo liable to confiderable variety; owing to its being more or lefs intermixed with hornblende. With a very fmall admixture of hornblende, it acquires a greafy luftre; and has a hardly preceptible fifkin-green colour: with a greater proportion of hornblende, it has a pale fifkin-green colour, with

with a weak degree of luftre and tranfparency, and a plain fplintery, or imperfectly conchoidal fracture: and laftly, with a ftill greater quantity of hornblende, it has a dark fiskin-green colour, with little tranfparency, and a coarfe fplintery fracture.

Dark, approaching to leek-green coloured FELSPAR—
I-columb-kill.

The felfpar of the fienite is generally of a brick or flefh-red colour; but is alfo of various fhades, from pale to dark leek-green: this is owing to its being more or lefs penetrated with chlorite or hornblende.

HORNBLENDE ROCK, having the appearance of ferpentine—*I-columb-kill.*

This rock is of a dark green colour, and is compofed of minute cryftals of hornblende, with a fmall portion of quartz; which has a dark fifkin-green colour. Similar rocks have been obferved in other countries: thus Humbold and Charpentier, in their difpute with regard to the magnetic property of a ferpentine rock, remark, that it has often a great refemblance

blance to hornblende rock *; and Mr Kirwan in his geological Eſſays, hints, that hornblende rocks may be miſtaken for ſerpentine. The greater ſpecific gravity, and the cryſtalline texture of the hornblende rock, diſtinguiſh it from ſerpentine.

MARBLE, or DOLOMITE, *of I-columb-kill.*

Colour. Snow-white, but frequently verging to yellow, or ſiſkin-green, from the admixture of talc.

Luſtre. Hardly perceptible, and only from a few diſperſed foliae.

Fracture. Splintery, paſſing to the even ; rarely granular foliated, and ſometimes imperfectly ſhiſtoſe.

Tranſparency. Tranſmits light at the edges.

Hardneſs. Yields with difficulty to the knife.

Chemical character. Diſſolves very ſlowly in acids, which is a good teſt for diſtinguiſhing it from other kinds.

Ac-

* Neuis Bergmanniſchis Journal.

According to Mr Tennant, 25 grains afford, of carbonic acid and water about 12, magnefia 4.4, lime 7.8, and 1.0 infoluble fubftance.

Use as a Manure. As this marble contains a confiderable portion of magnefian earth, it is probable that it will produce fimilar effects, when laid on the ground, with the magnefian limeftone examined by Mr Tennant *. I fhall therefore mention the fact which he difcovered; as it will be of confequence, not only to the inhabitants of this ifle, but to farmers in general. This gentleman informs us that, in the neighbourhood of Doncafter, two kinds of limeftone are employed in agriculture: the one, which contains two thirds of magnefian earth, muft be ufed fparingly, and fpread evenly over the ground; for, if ufed abundantly, it diminifhes the fertility of the foil, and prevents vegetation for feveral years: the other, which is pure limeftone, altho' laid upon the ground in great quantities, is never injurious—on the contrary, produces much fertility. Farmers fhould therefore be careful to examine whether the limeftone they are to employ diffolves flowly in acids; as this

* Philofophical Tranfactions of the Royal Society of London, 1799. Part 2d, p. 305.

is the character which marks the presence of the magnesian earth.

Flexibility and Elasticity of Dolomite.

In the Borghese palace at Rome, there is a slab of dolomite, which possesses a very considerable degree of elasticity and flexibility, and Mr Fleuriau de Belvue has discovered a nearly similar stone at Mount St Gothard in Switzerland *. He observed that all the specimens which possessed this property, were to be obtained only from the outside of the strata, and in the parts which had been most exposed to the weather. This circumstance led him, along with Mr Dolomieu, to suppose, that its peculiar properties were owing to the separation of a part of its water, which thus weakened the adhesion, and probably altered in a small degree the arrangement of the integral mollecules. He confirmed this idea, by exposing Carrara marble, gypsum, and other inflexible stones to a low degree of heat, by which they acquired a considerable degree of elasticity and flexibility. He found, however, that it was only those marbles that had a crystalline grain, and contained little iron or argill, that could be made flexible and elastic.

As

Journal de Physique, p. 2. 1792.

As the dolomite of I-columb-kill agrees in many of its properties with that from St. Gothard, it deferves to be tried whether it will become flexible and elaftic, by treating it as directed by Mr Fleuriau de Belvue. His procefs is very fimple: he puts a thin flab of the marble into a fand bath, and keeps it at the temperature of 30° of Reaumeur for an hour and a half, or, if it be a pretty large flab, for a confiderably longer time. He then removes it, and allows it to cool, and even to abforb a little moifture; and then preffes it in all directions, fo as to deftroy that adherence among the particles which the fire has not affected.

NEPHRITE.

Talcum Nephriticum, Lin. & Wern. *Jade*, *Beilstein*, & *Bitterstein*, German.

Colour. Yellowifh or fifkin-green; olive-green; and fometimes approaching leek-green.

Fracture. Coarfe or fine fplintery.

Tranfparency. In pretty thin pieces, it allows objects to be feen through it indiftinctly, but is generally more opaque.

Hardneſs. Sometimes gives fire with ſteel. In other ſpecimens, is difficultly ſcraped with a knife.

Feels greaſy.

It is diſperſed thro' the marble, and is ſeen paſſing gradually into it; has ſometimes ſcales of mica mixed; and not unfrequently we obſerve narrow veins of aſbeſtos traverſing it. It is a curious fact, that the pieces we find upon the ſhore are often harder than thoſe which we break out of the marble.

The only uſe that is made of it, is for ornamental purpoſes; but the pieces which have been found in I-columb-kill are generally too ſmall for any fine work. In Turkey it is wrought into very elegant handles for daggers and ſcimitars; and La Metherie remarks that the many fine pieces in oriental nephrite may have been made before it acquired its preſent hardneſs, which, he ſuppoſes, was produced by expoſure to a gentle heat ‡. Some of the pieces which have been found in Iona are extremely beautiful; and there can be no doubt that, were it quarried on purpoſe, many magnificent ſpecimens might be obtained.

BA-

‡ Theorie de la Terre, tom. 2.

BASALT COLUMNS *of Staffa.*

Several years ago, Mr St. Fond analyfed this bafalt, and found it to contain, in the hundred parts—filex 40, argil 20, lime 12, magnefia 5, iron 21. More lately, Dr Kennedy of Edinburgh has repeated this analyfis, and found nearly fimilar ingredients; with the difference, that he always obtained a fmall portion of foda and muriatic acid. According to his trials, 100 parts contain—filex 48, argil 16, oxyd of iron 16, lime 9, moifture and other volatile matter 5, foda about 4, and muriatic acid about 1.

COLL

COLL AND TIRIE.

CHAP. XVIII.

Outline of the MINERALOGY *of* COLL *and* TIRIE.

HAVING examined as much of the iſlands of Mull and I-columb-kill as our time would permit, we took leave of the worthy family of Torloiſk, and walked to the harbour of Quines, which is ſituated upon the north-weſt part of Mull. Here we luckily found a boat about to ſail for Coll, an opportunity which we gladly embraced; and, after a tedious paſſage of ten hours, we landed at the ſeat of Colonel Maclean, where we were moſt politely received.

COLL.

COLL.

THIS iſland is about fourten miles long, and two miles broad. It is low, rugged and bleak; but in ſome places there are beautiful flats, which, during the ſummer, being cultivated, or adorned with wild flowers, form a ſtriking contraſt with the weather-beaten rocks which ſkirt them. The ſhore, upon the eaſt ſide, is generally low and rocky; on the weſt, it riſes into conſiderable cliffs, and, in many places of this ſide, great ſand-banks extend for a conſiderable way. Theſe banks are often of conſiderable height, and form groupes of ſandhills; which are ſometimes covered with the Arundo arenaria, Galium verum, &c.; but more frequently they preſent only a dreary waſte: for, during ſtorms of wind, the ſand riſes in clouds, to overwhelm and deſtroy the neighbouring country. The inhabitants have themſelves partly to blame for the continuance of this evil, by their obſtinacy in rooting up certain plants which prevent the blowing of the ſand: thus, it is a common practice to uſe the Arundo arenaria as a ſubſtitute for ropes, and the Galium verum as a yellow die; two plants which are very re-

markable

markable for their power in binding the ſand. Colonel Maclean has prohibited this very pernicious practice, by ſevere penalties; which, it is hoped, will have the deſired effect.

Mineralogy. At the Loch, where is ſituated the ſeat of Col. Maclean, the iſland is low; but upon the E. and W. great ſand-banks appear. The loch is ſmall, rocky and ſhallow; ſo that, in ſtormy weather, it can afford very little ſhelter for veſſels. If we proceed along the ſouth part of the iſland, towards Loch Alin, conſiderable ſandy beaches preſent themſelves; but they are now and then interrupted by tracks of gneiſs. This gneiſs is traverſed, in ſeveral places, by great veins of granite. The granite, which fills theſe fiſſures, is eaſily diſtinguiſhable from that which is depoſited in ſtrata, by the great ſize of its conſtituent parts. Dolomieu, during his travels, often obſerved granite in veins, which, he remarks, is eaſily diſtinguiſhed from that which forms ſtrata; and Mr Beſſon alſo informs us, that the granite veins of Limouſin are diſtinguiſhed from thoſe in ſtrata by the great ſize of the felſpar and quartz. This is not, however, always the caſe; for Mr Charpentier has mentioned veins of ſmall-grained granite which he ſaw in Saxony †, and I have obſerved ſimilar appearances in the Highlands of Scotland.

† Charpentier, Mineralogiſche Geographie der Chursachsischen lande, § 261, 270.

Scotland. At Loch-Alin, Col. Maclean ſhowed us a ſmall vein of Galena, about three inches wide, traverſing the gneiſs and ſienite ſtrata; but it was ſo near the ſhore, that we had not an opportunity of tracing it but for a ſhort way. Such an appearance, however, deſerves farther inveſtigation, when we conſider, firſt, that veins of ore, altho' very trifling at the ſurface of the earth, increaſe much as they deſcend, which is the caſe with the rich mines of Freyberg and Franconia; ſecondly, that the rock, in which this vein runs, is, in other countries, extremely productive of rich ores; thus we know that the greater part of the Saxon, Bohemian and Saltzburg mines are ſituated in mountains of gneiſs. Near to this mineral appearance, I obſerved ſeveral veins of baſalt traverſing the gneiſs; and one of them ſeemed to run nearly in the ſame direction with the ſtrata: thus intimating that a rent had been formed in the ſame direction with the ſtrata, or that this baſaltic matter really forms a ſtratum which has been depoſited along with the gneiſs; of courſe, it ought to be conſidered as of primitive formation.

As we continued our journey around the iſland, I obſerved the gneiſs ſtrata interrupted by a ſmall extent of quartzy rock, which contained beautiful cryſtals of actynolite. This was again ſucceeded by ſtrata of gneiſs, which, in ſome places, form hills, that are often covered with immenſe looſe maſſes, broken

 from

from the ſtrata by the power of the weather. Upon examining theſe maſſes, I obſerved them ſometimes reſting upon ſmaller pieces, as if they had been raiſed by the hand of art; but a more cloſe examination ſhowed us, that the ſmaller maſſes were the more ſolid parts of the gneiſs, that ſtill reſiſted the influence of the weather. This fact will explain many of the curious appearances called Rocking Stones, which antiquaries have been often pleaſed to conſider as proofs of the early knowledge of our anceſtors in powerful machinery. This gneiſs continues to the farm of Knock; but it is now and then to be obſerved alternating with micaceous ſhiſtus and hornblende ſlate, and frequently all theſe ſtrata are traverſed with baſalt veins. The hornblende, in ſome places of this track, but particularly at Griſſopool, is moſt beautifully cryſtallized; ſo that, with very little trouble, magnificent ſpecimens may be procured. At Knock, the gneiſs is much traverſed with baſalt veins, which are of various ſizes; ſome not exceeding a quarter of an inch in width, while others are more than three feet. The gneiſs here contains a very great proportion of a red-coloured felſpar; and the quartz has ſometimes a ſiſkin-green colour, ſimilar to that which we obſerved in the iſland of I-columb-kill. From Knock to the northern extremity of the iſland, gneiſs, hornblende rock and micaceous ſhiſtus are the principal rocks

which

which occur; and from the north point, all along the eaft fide, to Colonel Maclean's houfe, the fame ftrata continue.

In fome places of the interior of the ifland, I obferved confiderable cliffs of quartz, which is either maffive or granular, refembling that from the ifland of Jura *; but I had not an opportunity to determine its fituation with regard to the gneifs, or the other primitive rocks of which the ifland is compofed.

* Mr Fleurian de Belvue, as I have before mentioned, having found that different fpecies of marble, by being heated, acquired a confiderable degree of flexibility and elafticity; alfo made a feries of experiments on different kinds of fandftone and granular quartz. He found that feveral of them, by being made repeatedly red-hot, and then plunged into water, acquired a remarkable degree of flexibility; and that fome kinds of granular quartz became even as flexible as the famous elaftic ftone which was brought from the Brazils. The granular quartz of Coll is quite the fame with that which Mr Belvue ufed for his experiments; and there is no doubt that, if it be tried, it will acquire the fame curious property.

TIRIE.

THIS iſland, which is ſeparated from Coll by a narrow ſound, is about eleven miles long, and two miles and a half broad. It has many ſand-banks, like thoſe in Coll, which are alſo very deſtructive. There are a few hills, which are from two to three hundred feet high; but the greater part of the iſland is low, with interſperſed rocks, and numerous ſmall lakes. This iſland, when viewed from an eminence, appears altogether ſterile and waſte; yet the quantity of arable land among the rocks is ſaid to equal half the extent of the iſland: a proportion vaſtly greater than that of Coll. In the middle of the iſland there is a large and very beautiful plain, which contains 1200 Scotch acres, and is elevated about ſix feet only above high-water mark. During ſtormy weather, the ſea not unoften meets acroſs this plain, and is productive of bad conſequences. The inhabitants have endeavoured to avert this evil by building a defence of ſtone and earth on the one ſide, while the ſea, on the other, has raiſed a conſiderable barrier of bowlder ſtones: yet neither have been ſufficient to reſiſt the waves of the Atlantic.

This

This iſland appears to have been formerly joined to the iſland of Coll; the iſle of Guna, which lies in the ſound, being apparently part of the intermediate land, which has eſcaped deſtruction. On this account, there is but little difference in their compoſition; the greater part of Tirie being formed of ſtrata of hornblende rock, gneiſs and ſienite, which are in general very much elevated. Theſe ſtrata are, in different parts of the iſland, traverſed with veins of baſalt; and, at the ſouth-weſt part of the iſland, I obſerved a great quartz vein, interſperſed with iron pyrites, traverſing theſe ſtrata; and alſo a great vein of compact arenaceous quartz, which is intermixed with leaves of talc, cryſtals of felſpar, and a few pieces of galena. Probably this vein, upon trial, might afford lead ore in ſuch quantity as to be worthy of working. It would be of little conſequence to enter into a detail of the ſlight alterations of the ſtrata in particular parts of the iſland; I ſhall therefore terminate my few obſervations, by giving a ſhort account of the marble quarry, which has rendered this iſland ſo remarkable.

The marble quarry is ſituated immediately upon the ſea-ſhore, at a farm called Belephetrich: here the ſhore is low and rocky; but at a little diſtance there is an eminence, called the Hill of Belephetrich. The ſtrata are nearly vertical; and are compoſed of hornblende rock, and a compound of deep-red

coloured

coloured felfpar and quartz, which has fometimes cryftals of hornblende interfperfed. The marble forms a ftratum of very confiderable extent; it appears alfo to be nearly vertical, and is bounded by the rocks we have juft mentioned. It is croffed in fome places by fmall veins of quartz and reddifh-coloured hornftone; and I obferved a vein of granite, compofed of felfpar and quartz, traverfing it. This ftratum of marble has been confidered by feveral travellers as a vein; but I apprehend this is a miftake. In other countries we find marble in a fimilar fituation: thus Voight * informs us that it has been obferved between hornblende flate and fienite, and even that it has been found between granite in Sweden †.

Upon the oppofite fide of the hill of Belephetrich, there is a ftratum of white marble, which is fituated among the ufual rocks which compofe the ifland. This ftratum feems alfo to have been quarried, but, like the other, is long fince given up as unprofitable.

AS

* Voight, Prack. 48.

† Ibid. Briefe ueber der gebergslehre, § 12.

AS I have to defcribe particularly only two foffils belonging to thefe iflands, it would be unneceffary to throw them into a diftinct chapter: I fhall therefore infert the defcriptions in this place.

Red-coloured MARBLE—*Belephetrich.*

Colour. Pale blood-red, light flefh-red, and reddifh-white.

Luftre. None, except from a number of difperfed fhining foliæ.

Fracture. Fine fplintery.

Tranfparency. Tranfmits light freely at the edges.

Hardnefs. Yields pretty eafily to the knife.

There are difperfed through it,

1. *Hornblende.* The cryftals are of various fizes, from the tenth of an inch to three inches long; and they vary fomewhat in the intenfity of the green colour. It is mixed in different pro-

proportions with the marble: fo as to produce pale blackifh-green, dark afparagus-green, and a colour approaching to leek-green. Tranfparent fea-green calcareous particles are frequently to be obferved intermixed with the hornblende, and alfo beautiful, but very minute garnets.

2. *Mica*—Is fometimes in pretty large plates; is of a yellow, tombac brown, or green colour; and appears paffing to fchiller fpar.

White MARBLE—*Belephetrich.*

Colour. White, or very light blue.
Luftre. Pretty confiderable, from the foliæ.
Fracture. Granularly foliated.
Tranfparency. Tranfmits light at the edges.
Hardnefs. Yields with difficulty to the knife.

There are difperfed through it fcales of mica and cryftals of hornblende. When the hornblende is minutely diffufed, it gives the marble a green, or yellowifh-green colour: then it has a fplintery fracture, with little luftre, and increafed hardnefs. Sometimes the hornblende feems to be very intimately combined

combined with the marble; when it forms thofe beautiful yellowifh green fpots, which have made this variety of the Tirie marble to be fo much admired. Thefe yellow fpots have been reckoned by fome mineralogifts as the fame with the fpargelftein of Werner.

Corundum, or Adamantine Spar, of Tirie.

The Honourable Mr Greville, in his memoir on the adamantine fpar, obferves—" I had obferved, in the fpecimens which Mr Rafpe called Jade, or a new fubftance from Tirie, on the weft coaft of Scotland, a great refemblance to corundum: but having then had only a curfory view of the fubftance, I am indebted to Mr Hatchett for the examination of a fpecimen of it, which he had from Mr Rafpe's collection. The Tirie ftone refembles cryftallized corundum of the coaft ‡, in texture and colour: it is alfo as refractory, when examined by the blowpipe, with different fluxes. Its fpecific gravity is 3.049; confequently nearer the fpecific gravity of pure corundum than the above mentioned lump 2.785, and the matrix of corundum 2.768. The Tirie ftone will fcratch grafs readily, but not rock cryftal: its hardnefs, therefore, correfponds with that of

‡ Coaft of Coromandel.

of the corundum *." I believe there are ſpecimens of this corundum in the Muſeum of the Univerſity; and of theſe I ſhall probably communicate an account at the cloſe of this volume.

EIGG,

*Philoſophical Tranſactions of the Royal Society of London, 1798, p. 40.

EIGG, RUME AND CANNA.

CHAP. XIX.

Outline of the MINERALOGY *of* EIGG, RUME *and* CANNA.

HAVING thus taken a general view of the iſlands of Coll and Tirie, we left with regret the hoſpitable family of Coll, whoſe numerous and polite attentions had rendered our ſtay in this iſland ſo agreeable.

We ſailed from the bay immediately below Col. Maclean's houſe, and, after a voyage of five hours, we landed upon the iſland of Eigg, and walked to Mr Macaſgill's, who, we found, was at that time on the mainland; yet, during our ſtay in this iſland, we experienced every attention from his family.

EIGG.

THIS iſland is the property of John Macdonald, Eſq. of Clanranald, is between four and five miles long, and from two to three miles broad. It is hilly; the principally flat and cultivated piece of country being confined to the ſhore oppoſite the mountainous iſle of Rume.

Mineralogy. The harbour upon the ſouth-eaſt extremity of the iſland, where we land in coming from Coll, is formed by a ſmall iſle, called Eillean-Chaſtell, which is compoſed of baſaltic rocks. The ſhore, immediately oppoſite to this iſle, is high; and the cliffs are ſplit into pretty regular baſaltic pillars, which are of conſiderable ſize. As we proceed towards the eaſt ſide, the ſhore becomes lower; but this is only for a ſhort way, as it ſoon riſes again upon the eaſt coaſt, forming cliffs of vaſt height. Theſe ſtupendous precipices extend all along the eaſt and north part of the iſland; forming many wild and romantic ſcenes, and affording ſeveral diſtinct views of the diſpoſition of the ſtrata. The ſtrata are nearly horizontal; and are, in ſome places, ſo well expoſed, that we can obſerve their

alternation

alternation from the level of the fea to the fummit of the cliffs. I fhall therefore, in defcribing them, begin with the lowermoft ftratum, which is,

1. *Shiftofe Clay.* This ftratum is a few inches thick; and is compofed of a dark-coloured fhiftofe clay, which contains numerous well-preferved fhells apparently of the genus tellina.

2. *Compact Limeftone.* This forms a thin ftratum, lying immediately upon the fhiftofe clay.

3. *Shiftofe Clay.* This ftratum is about ten inches thick, and refts upon the limeftone.

4. *Compact blue Limeftone, containing fhells.* This ftratum is about ten inches thick, and refts upon the fhiftofe clay. It acquires a yellow colour by decompofition; fo that it is well diftinguifhed from the other ftrata, even at a diftance.

5. *Shiftofe Clay.* This refts on the limeftone.

6. *Bafalt.* The covering of grafs prevented me from difcovering the bafalt in immediate contact with the clay; yet, from its vicinity, it is very probable that it covers it.

7. *Fi-*

7. *Fibrous Limeſtone.* The ſtratum of baſalt is covered by a thin layer of this ſpecies of limeſtone, which has a blackiſh colour from mixed bituminous matter.

8. *Baſalt.* This covers the limeſtone.

9. *Argillaceous Sandſtone.* An immenſe ſtratum of this ſandſtone lies upon the baſalt. It is in general ſoft, but we were told that ſometimes it is very hard. This harder kind is probably got by blaſting, as the interior of ſandſtone rocks, as Charpentier * obſerves, is the hardeſt; or it may be other harder ſandſtone ſtrata alternating with the ſofter, as I have obſerved in the Orkney Iſlands and other parts of Scotland.——This ſandſtone frequently contains impreſſions of ſhells; and it alterternates with ſtrata of baſalt, which are from four inches to ſeveral feet thick. This alternation renders it very probable that the baſalt may alſo contain ſimilar animal remains; and this conjecture is rendered the more probable from ſeveral facts which have been lately diſcovered. Thus Mr Kirwan informs us that Dr Richardſon had diſcovered ſhells in the baſalt of Ballycaſtle ‡; Bruckenman has obſerved muſcle ſhells, ammo-

nites

* Charpentier, Mineralogiſche Geographie der Chursachsischen lande, 44.

‡ Kirwan's Geological Eſſays, p. 252.

nites and corallites in the basalt of the pretended extinct volcanoes of France †; and impressions of leaves have been observed in basalt, as related by Lenz ‡.

10. *Basalt in columns.* This forms a great stratum, which covers the argillaceous sandstone. The columns are varied, not only in their size, and in the number of their sides, but also in their direction being perpendicular, horizontal, or bent, like those of Staffa. The bent columns are generally smaller in their dimensions than those that are perpendicular or horizontal.

11. *Wacken.* This forms an immense stratum, which we observe resting upon the basalt columns. It frequently contains beautiful crystallizations of zeolite.

12. *Red-coloured Wacken.* This stratum is only a few inches thick, and it rests upon the wacken. It is perfectly similar to that which we observed in Mull.

13. *Basalt.* This forms a great bed, which lies on the red-coloured wacken, or, when it is a-wanting, on the common wacken.

These

† 1 Chym. Ann. 1794. § 103, &c.

‡ Lenz. 374.

Thefe ftrata are traverfed in feveral places by veins of bafalt; which do not appear, in any inftance, fo far as I have examined, to have occafioned any alteration in their direction or hardnefs.

Nearly at the northern extremity of the ifland, the cliffs, we have now been defcribing, turn inwards, and run in a femicircular form, until they again appear upon the coaft on the weft fide of the ifland. The femicircular track, included by thefe cliffs, is pretty flat, of confiderable extent; and the cliffs, which bound it, are compofed of ftrata fimilar to thofe on the eaft and north fides of the ifland. The bottom, in fuch places as I examined, is compofed of ftrata of limeftone containing fhells, alternating with fhiftofe clay, and fometimes refting on bafalt or fandftone. Upon the fouth fide of this track the fandftone and limeftone difappear, and now bafalt and wacken form lofty precipices. Immediately at the bottom of thefe bafaltic rocks, upon the fea-fhore, I picked up feveral pieces of black pitchftone, much refembling that found in the iflands of Arran and Mull; but I could not difcover whether it forms veins or ftrata. From this to within a mile of Eillean-Chaftil, the ifland is bounded in many places by lofty precipices: and the interior is formed of irregularly-fhaped,

ſhaped, grey-coloured, columnar hills, and, among theſe, Scure-Eigg, which is the higheſt, has a very ſingular appearance.

In the ſea cliffs there are ſeveral conſiderable caves. They are generally ſituated in a wacken which is traverſed by baſalt veins. This wacken contains moſt elegant ſpecimens of capillary zeolite, alſo calcareous ſpar, quartz cryſtals, and chalcedony; and in ſeveral places I obſerved a red-coloured wacken ſimilar to that which is deſcribed at p. 235, vol. i. Several of theſe caves are of conſiderable extent, and are open to day; others are narrow at their entrance, but enlarge conſiderably as we go inwards.

The miniſter of this pariſh, who was ſo good as to accompany us to ſeveral parts of the iſland, led us, by a very rugged path, to a wild ſequeſtered ſpot, where there is a cave, remarkable, in the annals of this iſle, for the murder of the Macdonalds, inhabitants of Eigg, by the Macleods of Skye. As this ſtory is truly characteriſtic of the ſtate of ſociety in thoſe parts at that period, I think it will not be unintereſting to relate it ſhortly.

A party of the Macleods having landed upon the ſmall iſland of Eillan-Chaſtel, behaved ſo outrageouſly to the women who

 were

were there tending cattle, that their friends inſtantly purſued, and put ſeveral of them to death. This ſo enraged the clan of Macleod, that they determined to take revenge, by ravaging the iſle, and putting to death the murderers of their brothers. The iſlanders, ſenſible of their weakneſs, prepared to ſhelter themſelves, upon the firſt appearance of an enemy. Soon afterwards a number of boats were ſeen approaching the iſle; when the trembling inhabitants retired, in deſpair, to this cave, their only refuge. The Macleods ſoon landed, and traverſed the whole iſland; but, as they could diſcover no human being, they concluded that the Macdonalds had made their eſcape to the mainland, or to ſome of the adjacent iſlands. Diſappointed and enraged, they were about to leave Eigg, to return to Skye, when unfortunately one of the horde obſerved the mark of footſteps on the ſnow, and thus they were enabled to diſcover the cave where the wretched inhabitants had taken refuge. Shrieks of deſpair were interrupted for a little, by a propoſal of the Macleods, that if the murderers were given up to puniſhment, the other lives ſhould be ſpared. This was only a cruel aggravation of their ſufferings, as the Macleods were the aggreſſors. Connected, as the Macdonalds were, by the deareſt ties, they determined to periſh together, rather than to give up one of their number. The Macleods, with the moſt ſavage barbarity, inſtantly

inftantly kindled great fires at the mouth of the cave, which foon fuffocated the whole of the miferable inhabitants.

One often liftens even to fuch a tale, as to the defcription of a battle, without much intereft: but the view of the fcene never fails to awaken a keener fympathy—the circumftances are brought nearer to the mind, and feem to be paffing before us. We ftood on the very ground where this tragedy was acted, and felt our fenfibility increafed by the fequeftered and dreary place in which the deed was done. But even this intereft was faint, when compared to that we felt, when, after creeping for a confiderable way through a low and narrow entrance, half covered with brufhwood, we found ourfelves at laft within a large and gloomy cave, the extent and height of which we could not diftinguifh; and perceived the gleams of the lights we carried reflected from the bones and fkulls of the unhappy Macdonalds. The force with which the truth and all the circumftances of this dreadful tale ftruck at this moment upon our minds, and the ftrange variety of fenfations excited by an event fo extraordinary, it is not eafy to find words to exprefs.

The entrance of the cave is low and narrow, for about 12 feet. The cave itfelf extends to a height of 22 feet, the breadth 24 feet, and in length it extends inwards nearly 213 feet. The air was damp and raw. Our lights ftruck faintly on the black

 fides

ſides of the caves, without diſpelling that deep and ſolemn gloom, which harmoniſed ſo well with its melancholy ſtory. The projecting maſſes of the rock were dimly illuminated, while the ſkulls and ſcattered bones catched a ſtrong light. Our figures, too, touched with the paley flame, ſhowed the features, or an outſtretched arm, while the parts of the body removed from the light were loſt in the gloom. Even the deep and ſonorous voice of the parſon had its effect. The whole ſcene was admirably adapted for the canvas: but it would require a very rare talent in the painter who ſhould attempt it.

A ſhort way from this cave, after walking over rocks of baſalt and wacken, I obſerved on the ſhore two veins of black pitchſtone. Theſe veins are about ten feet diſtant from each other, are from half a foot to three feet wide, and are a little bent in their courſe. They run in a ſpecies of baſalt, which contains a conſiderable portion of zeolite, and in ſome places ſmall layers of chalcedony. The pitchſtone and baſalt are ſometimes intermixed at their junction, and even pieces of the pitchſtone appear immerſed in the baſalt. But the moſt remarkable circumſtance attending this pitchſtone, is the intermixture of one of the veins with a vein of hornſtone. This appearance

PITCHSTONE *and* HORNSTONE *veins traversing* BASALT, *ISLAND EIGG.*

pearance is reprefented in the plate *, where A is the bafaltic rock in which the veins run ; B is the vein of pitchftone, and C is the hornftone vein. The vein of hornftone, at D, is about two and a half feet wide ; but it varies much in this refpect, as it fhoots through the pitchftone. At F, the hornftone has inclofed a wedge-fhaped piece of pitchftone. At G H there are two ftripes of hornftone, one of them, G, containing a thin piece of pitchftone.

Thefe appearances may be explained, by fuppofing, that, after the vein of pitchftone had been formed, new rents extended both through it and the bafalt, and that thefe were afterwards filled with hornftone. The pieces of pitchftone inclofed in the hornftone, appear to have been broken off the pitchftone vein, and at the time when it was rent, and were afterwards furrounded by hornftone.

Altho' pitchftone has been difcovered in various parts of Europe, it has not been before defcribed as belonging to the rocks of trap formation. Haquet, indeed, mentions, that he obferved bafalt columns converted into glafs, among the bafalt of the Ve-

* It muft be underftood that the plate reprefents a horizontal fection of the pitchftone and hornftone veins.

Veronefe. This is very probably pitchftone; yet we cannot fay fo with certainty, as the appearance is not defcribed with fufficient exactnefs. Obfidian, however, which, as we have before obferved, is nearly allied to pitchftone, has been lately obferved by Humbold, ftratified with bafalt, at the top of the peak of Teneriff.

We now afcended from this to the Scure Eigg, which we have before obferved to be the higheft part of the ifland. This hill, from its peculiar fhape, has, at a diftance, a fingular appearance; but as we approach nearer, it rifes much in grandeur, and at length, a ftupendous columnar promontory burfts on our view. The whole of this promontory is perfectly mural, and extends for upwards of a mile and a half, and rifes to the height of feveral hundred feet. It is entirely columnar, and the columns rife in fucceffive ranges until they reach the fummit, where, from their great height, they appear diminutive. Staffa, which is the moft magnificent affemblage of natural columns that has yet been difcovered, is the only one that can bear a comparifon with Scure Eigg. Staffa is an object of the greateft beauty and regularity; the pillars are as diftinct as if they had been raifed by the hand of art; yet it has not the extent or fublimity of Scure Eigg: the one may be compar-

ed

Eng^d by R. Scott Edin^r.

Columnar PROMONTORY *of Scure-Eigg*

ed with the greateſt exertion of human power; the other is characteriſtic of the wildeſt, and moſt inimitable works of nature.

The columns are diſpoſed in different directions, being either perpendicular, curved, or horizontal. Sometimes we obſerve the horizontal pillars croſſing each other; the ſides of the horizontal columns appearing above and below the ends of thoſe horizontal columns which lie in a contrary direction. They vary conſiderably in the number of their ſides, having three, four, five, ſix, and ſeven ſides; but I did not obſerve any of them jointed. I conjectured, at firſt, from the nature of the ſtrata of which the iſland is compoſed, that theſe columns were baſalt; but a nearer examination ſhowed that they were formed of a ſpecies of porphyry, with a baſis intermediate between baſalt and pitchſtone. The ſame kind of porphyry ſeems to form many of the other hills in the interior of the iſland.

RUME.

RUME.

AS the voyage from Eigg to Rume is rather dangerous, on account of the terrible ſqualls of wind which often blow from the high lands, we did not prolong our ſtay, after we had made the few obſervations which have been juſt mentioned. We therefore ſailed from the weſt ſide of the iſle of Eigg, and, after a pleaſant ſail, we landed at Kinloch, at the head of Loch Skreſert in Rume. Here we had our exertions aſſiſted by Col. Maclean's officer, and the other people of the iſland, who manifeſted every wiſh to ſerve us.

Description. This iſland, which is the property of Col. Maclean of Coll, is about eight miles long, and nearly as broad. It lies between the iſles of Eigg and Canna, and is about ſeven miles NNW, from Eigg, and four from Canna. It is altogether mountainous; in ſhort, it may be reckoned a groupe of mountains, of which, Aiſgobhall is the higheſt. Its ſhores are in general very bold and rocky, and often preſent tremendous perpendicular precipices.

Loch-

Loch-ſkreſort, which is the only harbour in the iſland, is about two miles long, and is bounded upon both ſides by hills of conſiderable height, which riſe pretty rapidly from the ſides of the loch. The ſtrata upon both ſides are of red-coloured ſandſtone. At Kinloch, the ſmall village at the head of the loch, the land is low and continues pretty much ſo, to the ſhore oppoſite to the iſland of Canna, forming a kind of valley which is bounded by lofty hills, which are more rugged upon the ſouth than the north ſide. The bottom of this valley is elevated in the middle; and here we obſerve another valley which runs quite in a contrary direction. The hills upon the north ſide of this valley are compoſed of red-coloured ſandſtone, which is elevated at an angle of 12°; and it is alſo ſtratified with baſalt, and traverſed by baſalt veins. Theſe veins are even to be obſerved burſting out upon the top of the hills; and often the baſalt, in theſe veins has a remarkable power over the compaſs: detached pieces act very powerfully. The ſandſtone by decompoſition aſſumes various tints, as red, purple, white, &c. and often it alſo decompoſes in ſlates; and theſe are frequently curved. Upon the ſhores, maſſes of onyx and ſardonyx are to be obſerved; probably coming from the ſandſtone or baſalt.

As the mountains upon the fouth fide of the loch are much higher than thofe upon the north, and their fhape and general appearance confiderably different, we agreed to afcend one of them, fo that we might become acquainted with the rocks of which it is formed. Accordingly, we began to afcend the mountain called Halival, which rifes immediately from Kinloch, but found it fatiguing not only on account of the wetnefs of the ground, but alfo from the many hollows into which we frequently tumbled, owing to their being concealed by long heather. Having reached the firft fhoulder of the hill, we found an extenfive platform, which is formed of bafalt and greenftone; and the fandftone which had continued from the bottom of the hill, does not go higher than this. Above this platform, the appearance of the hill is much altered, the heather difappearing, the fide of the hill being covered with grey ftones, and appearing to rife by a fucceffion of platforms or terraces. We now clambered upwards over a wildernefs of ftones of greenftone and bafalt, until we were about 60 feet from the fummit. Our further progrefs feemed now to be ftopped, as the mountain appeared to be furrounded by large blocks of greenftone ftanding in an almoft perpendicular direction. Our guide, however, conducted us to the fummit by a fteep path, which was not without danger. Unluckily, a few minutes before we reached the fummit, it was envelopped in clouds, fo that

that it was only as they cleared away, that the mountain of Aifgobhall was to be obferved towering above us; and by its terraced afpect, announcing a fimilarity of compofition with that on which we were ftanding. At fome diftance feveral other hills appeared with terrible, bare, rugged, intervening glens; and all apparently compofed of trap-formation rocks. As we were refting upon the fummit, I picked up fpecimens of a dark green-coloured cryftallifed pitchftone; but I did not difcover it *in fitu*: near to the fame places, I obferved feveral pieces of a rock refembling the Lydian ftone which feemed to traverfe the greenftone in the form of veins. As the clouds were now fpreading all around, we found it neceffary to defcend; but we took a different rout, fo that we might fee as much variety of rock as poffible. We did not, however, meet with any foffil differing from what we had feen in the afcent; and the difpofition of the ftrata appeared to be the fame, viz. greenftone and bafalt forming the higher parts, and red fandftone the lower. From the flight examination of this mountain, and the general appearance of the others in the neighbourhood, it is probable that all the fouth fide of the valley is formed of fandftone in the lower parts, and the upper of rocks of trap formation.

I cannot omit mentioning a curious appearance which I obferved, in examining a ravine upon the fouth fide of the valley,

 where

where it was ſaid coal had been found. Immerſed in the baſalt, which forms part of theſe hills, I diſcovered pieces of limeſtone, (with interſperſed bituminous matter,) from 4 to 12 inches long, and 2 inches in diameter. In the Philoſophical Tranſactions of the Royal Society of London for 1796, we have the account of a nearly ſimilar appearance obſerved in the works of the Huddersfield canal. In perforating a hill by a ſubterraneous tunnel, the workmen met with a fault or break in the ſtrata through which they were cutting, when they found a rib of limeſtone, and a number of pyritical limeſtone balls, from one ounce to upwards of 100 lb. weight. No limeſtone had been diſcovered in that country nearer than 20 miles. In Rume, ſo far as I could learn, there is not any ſtrata of limeſtone: a circumſtance which may poſſibly render the explanation of theſe phenomena a little difficult.

As circumſtances did not allow us to ſpend more time in this iſland, we left Kinloch, and, after a rugged walk during a violent ſtorm, we reached the ſhore of the iſland oppoſite Canna. Here we found a moſt magnificent, bold, broken coaſt, formed of ſtrata of red-coloured ſandſtone, which are elevated at a conſiderable angle, and alternate with baſalt, and are alſo traverſed with numerous veins of baſalt.

Beſides

Befides thefe appearances, I obferved, as we were walking along the fhore, waiting until the ftorm fhould allow us to crofs to Canna, vaft ftrata, apparently of bafalt, or wacken, lying on the fandftone, at the fummit of the tremendous cliffs which here bound the ifland. I now regret extremely that the inclemency of the weather prevented me from examining thefe ftrata; for unqueftionably they would have proved highly interefting, if we may judge from the fpecimens that had tumbled from them upon the beach. The following are a few of the foffils which I picked up on the fhore.

1. Green, or yellowifh-green coloured heliotrope *, which adhered to maffes of bafalt ‡, or forming little balls immerfed in it.

2. Bafalt, containing rounded balls of green earth, along with fimilarly-fhaped maffes of calcareous fpar.

3. Bafalt,

* This heliotrope is fometimes fo foft, that it has a good deal the appearance of pitchftone.—Is this owing to its being altered a little by the action of the weather?

‡ From the fpecimens being a good deal decompofed, I cannot fay with certainty whether this is to be confidered as a bafalt or a wacken; I at prefent rather think it is a bafalt.

3. Bafalt, containing chalcedony: and this chalcedony is frequently penetrated with the green-coloured heliotrope, forming a ftone that feems to be the plafma of the Italians.

4. Bafalt, with whitifh, or light-brown coloured hornftone, which has fometimes an apple-green colour, from its being penetrated with heliotrope.

5. Maffes of hornftone, which contain beautiful quartz cryftals.

6. Chalcedony in ftalactites; and, what is remarkable, pieces of the ftalactites are obferved lying in, and furrounded by calcareous fpar.

7. Beautiful maffes of onyx, which are, in fome fpecimens, covered with a white cruft.

The weather having now become a little more moderate, we croffed the found to Canna, thro' a very tremendous fea.

CANNA.

CANNA.

THIS iſland, the property of John Macdonald, Eſq. of Clanranald, is about five miles long, and two miles broad. It is low; but its ſhores are bounded by ſteep and lofty cliffs. It is remarkable for its harbour, which is reckoned one of the beſt among the Hebrides: yet it is difficult of approach in ſtormy weather, owing to the narrowneſs of the entrance, and the ſunk rocks that lie near it. This harbour is formed, upon the N. by Sand iſland, which is ſeparated from Canna by a ſtrait, which is left nearly dry at every ebbing of the tide. The iſland is low, and conſiſts of rocks of trap formation. The end, which forms the entrance of the harbour, is of baſalt tuff, having baſalt pillars reſting upon it. The oppoſite ſide of the harbour is formed by the iſland of Canna, which is here of conſiderable height, and riſing by beautiful and regular terraces. Theſe terraced appearances, which are in general pretty ſure marks of a baſalt country, do not here deceive us, as the rocks are decidedly baſaltic, and in ſeveral places are ſplit into columns.

In

In examining this iſland, we walked along the ſhore towards the W. which we found low and rocky, but bounded by conſiderable land-cliffs of columnar baſalt. This baſalt, in ſome places, reſts upon baſalt tuff; but, farther on, I obſerved the tuff expoſed without any covering—the baſalt, if it had ever been ſuper-impoſed, being waſhed away; and, near to the place, the baſalt pillars are ſeen wore down by the action of the ſea, the ends ſtanding up under the water like a regular pavement. At a place called Tarbet, the cliffs on the ſhore aſſume a bold form: they there riſe to a great height, and are immediately waſhed by the ſea, or, in other places where there is an accumulation of debris, the further action of the waves is prevented. The ſuperior ſtratum of theſe cliffs is columnar baſalt. The pillars vary very much, not only in ſize, but alſo in the number of ſides; and frequently they are to be ſeen bent, when their length and breadth is leſs than the upright ones. Immediately below the ſtratum of baſalt, there is a ſtratum of wacken, which contains calcareous ſpar, elegant capillary zeolite, quartz cryſtals, blackiſh-coloured cryſtals, whoſe nature I am ignorant of, and, more rarely, cryſtals of leucit, or Veſuvian garnet. To this ſucceeds another ſtratum of baſalt; and below it, a ſtratum of wacken; and ſo on, alternately, to the bottom of the cliffs.

Having

Having walked for a confiderable way along a narrow path in the face of thefe cliffs, the violent wind and rain forced us to fcramble to the fummit, as it was impoffible to walk longer in this track, without the rifk of being precipitated into the fea, or among the rocks. We now croffed the ifland to a place called Dun-eudain, where coal had been formerly wrought: unluckily the cliff had fallen down, fo that I had not an opportunity of feeing it. We were told, by the people who had worked it, that it was a ftratum from 6 to 8 eight inches thick, and was inclofed in whin rock (bafalt or wacken). Its fituation, upon the face of a high cliff, was given as the reafon why the working was ftopped: this is a circumftance, however, of little detriment; for, if the coal ftratum had been of confiderable extent, many economical expedients might have been ufed to raife the coal. From this, in going around the other parts of the ifland, the cliffs become lower; but they foon rife again, and continue of great height nearly to the harbour of Canna. In many places of thefe cliffs the ftrata are well expofed: thus, upon the eaft fide, near to Compafs-Hill, the uppermoft ftratum is bafalt, with a flight tendency to the columnar form; below this, is a ftratum of bafalt tuff; this is again fucceeded by bafalt; and fo on, alternately, to the bottom of the cliffs. The fhore is covered with a vaft collection of debris from the cliffs; and, in fome places,

 it

it even feems to form a kind of alluvial breccia, in which vaft maffes of columnar bafalt are immerfed.

Compafs-Hill, which we have already mentioned, is fituated at the top of the cliffs we have been juft defcribing; and appears, at its fummit, to be formed of a fpecies of bafalt, which, by decompofition, acquires the power of affecting the compafs: hence this eminence has received its name. Other rocks in the ifland, however, are much more powerful in this refpect: thus the bafalt at the outer point of the harbour affects the compafs at the diftance of between 25 and 30 feet.

Near to this hill, but immediately upon the fhore, there is an ifolated rock, called Humbla, which is interefting to the antiquarian, as there is upon its fummit the ruin of a fmall caftle, where, it is faid, an old jealous highland chieftain, even long ago, vainly endeavoured to confine a handfome wife. At a little diftance, there is another rock, where bafalt tuff lies on bafalt; and, in the tuff, I obferved feveral pieces of wood flightly bituminated. In one place I faw a piece of wood about two feet long, but only a few inches thick: thus intimating that it had acquired its fhape either by the preffure of the fuperincumbent rocks, or by the contraction of the argilla-

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ceous earth of the bafalt *. In proof of this latter opinion, which feems the moft probable, I may obferve, that the carbonated wood found in limeftone, or among coal, is never obferved to be flattened.

As the appearance of wood, thus flightly altered, in a rock of trap formation, is interefting for geology, I will now fhortly mention a few fimilar appearances which have been obferved in other parts of the world. At Stackhoufe, in Wefterwald, there are ftrata of carbonized wood, which alternate with wacken and clay †. Mr Efmark obferved a vein, at the depth of 200 fathoms, entirely filled with carbonized wood ‡. Werner mentions veins of wacken, at Bautzen, that contain pieces of bituminated wood ||. Near Rennes, a whole chefnut tree was obferved lying horizontally among fhiftus; of which the bark was converted into pyrites, the fap into jet, but the center was wood flightly altered, being nearly in the ftate of charcoal.

* Kirwan's Geological Effays, p. 46.

† 1 Berl. Beob. 52, 56. Kirwan's Geological Effays, 311.

‡ Neues Bergmannifches Journal.

|| Werner Neue Theorie von der Entstehung der Gange.

coal *. Mr Pennant informs us that wood is found inclofed in the folid rock in different parts of Iceland, and, like that of Canna, is very much flattened: what is remarkable, pieces of the wood are often found fo little altered, and of fuch a fize, as to be eafily planed, and made into middle-fized tables ‡.

EIGG,

* Journal de Phyfique, Mai, 1786.

‡ Introduction to Arctic-Zoology, p lx.

CHAP. XX.

Defcription of the Fossils *mentioned in the preceding Chapter.*

Columnar PORPHYRY of *Scure-Eigg.*

This rock has, difperfed thro' it, numerous cryftals of yellowifh or white-coloured cryftals of felfpar; and the bafis prefents the following characters:

Colour. Black.

Luftre. Little glancing, or rather glimmering.

Fracture. Even, approaching more or lefs to the conchoidal.

Tranfparency. None.

Hardnefs. Gives a few fparks with fteel; but fometimes yields alfo with great difficulty to the knife.

It decompofes into a greyifh-white powder.

Fufibility.

Fufibility. At 29° it had acquired a grey or white colour, and was converted into a kind of enamel.

This change by action of the heat, conjoined with the external characters, confirm me in the belief that it is intermediate between pitchftone and bafalt.

PITCHSTONE—*Eigg.*

Colour. Deep black, or bluifh-black.

Luftre. Pitchy, ftrong glancing.

Fracture. Uneven; or, even, with a greater or lefs tendency to the conchoidal; and fometimes fhiftofe.

Tranfparency. None.

Hardnefs. Scarcely gives fire with fteel.

Fufibility. Formed a black cellular mafs at 47°, and at 52° was more compact.

There are, interfperfed, a few cryftals of felfpar, and thin layers of a yellow-coloured fubftance.

HORN-

HORNSTONE, which traverfes the Pitchftone—*Eigg*.

Colour. Pale greenifh-grey.

Luftre. None.

Fracture. Even, or fine fplintery.

Tranfparency. Hardly perceptible at the edges.

Hardnefs. Gives fire pretty plentifully with fteel.

There is, difperfed thro' it, calcareous fpar and chalcedony. The chalcedony is of a bluifh-white, or light-yellow colour; and is fimilar to that which I have mentioned in the preceding chapter, as being contained in the bafalt. It is fometimes cellular; and thefe cells are lined with quartz cryftals, and filled with a nearly liquid bitumen.

BASALT, in which the Pitchftone Veins are fituated—*Eigg*.

Luftre. Little glancing, from a number of minute cryftals of hornblende which are difperfed through it.

Fracture. Uneven.

Hardnefs.

Hardneſs. Yields with ſome difficulty to the knife; and leaves a grey trace.

By decompoſition it acquires an iron-grey colour.

GREENSTONE—*Rume.*

It is compoſed of cryſtals of hornblende and felſpar; and, intermixed, there are beautiful tranſparent graſs-green coloured cryſtals, which reſiſt decompoſition, while the felſpar and hornblende are reduced to an iron-brown or greyiſh powder. It has a very great ſpecific gravity.

Cryſtallized PITCHSTONE—*Top of Halival, Rume.*

It is of an olive, or dark leek-green colour; and has the uſual luſtre, tranſparency and hardneſs. The cryſtals are immerſed in a rock formed of felſpar, with a few ſcales of tombac-brown coloured mica. They are from the tenth to the half of an inch long; which is much greater than the cryſtallized pitchſtone of Bohemia. I could not diſcover the form of the cryſtals, on account of their being much broken; yet I have no doubt that it

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is a cryſtallized pitchſtone. As this is a very rare foſſil, having been diſcovered only in another part of Europe, it is well deſerving the attention of thoſe who viſit Rume.

CHALCEDONY—*Rume.*

This chalcedony is of a bluiſh-grey, or browniſh colour, or even of a milk-white colour, thus approaching to the nature of ſemiopal; and has the uſual luſtre, tranſparency and hardneſs. It is frequently accompanied by calcareous ſpar, hornſtone, and cryſtalliſed quartz. It is alſo ſtalactitical; and, what is curious, we ſometimes obſerve fragments of the ſtalactites incloſed in the calcareous ſpar *. It is frequently penetrated with

helio-

* The explanation of the formation of ſiliceous or chalcedonic ſtalactites has been conſidered a difficult problem in geology, and no doubt there is ſome truth in the opinion. Upon reading with a view of collecting facts on this ſubject, I met with one which deſerves to be generally known, as it will help to explain ſeveral of the remarkable forms that the ſtalactitical chalcedony aſſumes. Baron Trebra, whilſt in the deepeſt mines at Kromnitz in Hungary, paid particular attention to the appearance of the ſiliceous ſtalactites, and obſerved that thoſe newly

formed,

heliotrope, or bloodſtone ; when it has characters exactly reſembling the plaſma of the Italians.

PLASMA ?—*Rume.*

Colour. Dark apple-green.

Luſtre. Glimmering.

Tranſparency. Sometimes allows the light to paſs thro' pretty freely.

Fracture. Even, with a tendency to the flat conchoidal.

Hardneſs. Does not give fire with ſteel ſo readily as chalcedony.

This ſtone was formerly conſidered as a ſpecies of chalcedony ; but Werner has lately deſcribed it as a diſtinct genus. Abbé

formed, or forming, in place of breaking, as is the caſe with the calcareous, were flexible, and this in a very great degree ‡.

‡ Mineralien cabinet gesammelt und beschrieben von dem Verfaſſer der Erfahrungen von innern der gebirge.

Abbé Eſthner conſiders it as an intimate combination of calcedony and talcerde. This may be the caſe with the ſpecimens he examined; for I have little doubt that chalcedony may, in one inſtance, be penetrated with heliotrope, and, in the other, with talcerde, yet the reſulting foſſils may be difficultly diſtinguiſhable by their external characters.

Dark apple-green coloured HORNSTONE—*Rume.*

Luſtre. None.
Fracture. Coarſe ſplintery.
Tranſparency. Allows a little light to paſs at the edges.
Hardneſs. Gives ſparks very plentifully with ſteel.

It has browniſh-coloured ſpots diſperſed thro' it. This appears to be hornſtone penetrated with heliotrope; and the ſuppoſition is rendered more probable, from the diſperſed brown-coloured ſpots, which are characteriſtic of the preſence of heliotrope.

HELIOTROPE, or, ORIENTAL JASPAR—*Rume.*

CHALCEDONIUS HELIOTROPIUS, Lin. *XANTHUS*, Walker.

Colour. Dark grafs-green, or yellowifh green; and marked with fpherical fpots of an iron-brown, or light olive-green colour.

Luftre. Glimmering, with a weak waxy luftre.

Tranfparency. Very little at the edges.

Hardnefs. Gives fparks plentifully with fteel, but not fo much as flint.

The red, olive-green, or iron-brown coloured fpots and veins are merely accidental, as the fame ftone is to be found without them. It is confidered by Emmerling as an intimate of green earth and chalcedony; and this is countenanced by its fituation in Rume, as both green earth and chalcedony are found accompanying it. A foffil of this name is defcribed by Pliny, at the 10th chapter of the 37th book of his natural hiftory; but its properties are fo different from the ftone with which we are acquainted, that we muft, for the prefent, confider it as different. It is to be hoped that the intelligent and well-informed Mr Hawkins, who has travelled over fo much of the Eaft, where

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it is ſaid the heliotrope of Pliny is found, will clear up this difficulty.

BASALT TUFF—*Canna.*

This rock is compoſed of rounded maſſes of baſalt, wacken mandelſtein, and argillaceous ſandſtone, connected by a baſaltic baſis. Very conſiderable looſe maſſes of ſandſtone are to be obſerved in different parts of the iſland; and ſeem to be derived from this breccia or baſalt tuff: as I did not obſerve any fixed rock of ſandſtone in the whole iſland.

SKYE.

S K Y E.

CHAP. XXI.

Outline of the MINERALOGY *of* SKYE.

HAVING ſpent two days in examining what was curious in Canna, we ſailed for the iſland of Skye, and, after a tedious paſſage, we landed at Rue-dunan, which is about 12 miles from the harbour of Canna.

The iſland of Skye is about 70 miles long; but it varies much in breadth, owing to the number of lochs or arms of the ſea with which it is interſected. Cambden imagines that it is the eaſtern Æbudæ of Ptolemy*, while others reckon it the Dumna. Its

* Ptolem. Geograph. lib. viii.

Its prefent name is of Norwegian origin, being derived from *Ski*, a mift ; and from the clouds that almoft perpetually envelope the lofty mountains, it has been ftyled *Ealand-fkianach*, or the cloudy ifland †. It lies between the mainland of Scotland, and the Long-ifland ; it is, upon the weft fide, many miles from the Long-ifland ; but on the eaft, it is feparated from the mainland in fome places by a found not half a mile broad. The fhores are rocky, and the cliffs in many places are of great height. It is very mountainous upon the SW. where the Cullin mountains rife to a great height, and afford many fcenes of the greateft fublimity. To the north of thefe mountains, the ifland is formed of comparatively low hills, which continue to within a few miles of the extremity, when they are fucceeded by a plain, which forms part of the parifh of Kilmuir. South from thefe mountains, is the low, narrow, parifh of Sleat, which forms a peninfula, that is reckoned the moft productive part of the ifland.

Caves. There are confiderable caves that occur in different parts of the ifland ; one at Camesketel, on the fouth fide, is fam'd for having afforded fhelter to the unfortunate Prince Charles when he was efcaping from Scotland after the battle of

† Dr M'Pherfon, in Pennant's Tour.

of Culloden. There are alfo, in feveral places, grand cafcades; one in particular, upon the eaft fide of the ifland, is reckoned little inferior to the fine fall at Fyers, which is between Fort Auguftus and Invernefs.

Lochs. This ifland appears, at fome former period, to have been very much expofed to violent convulfions, which have broke up the land, and formed the many lochs which traverfe it. The moft confiderable of thefe lochs are Snizort, Follart, and Bracadale.

Mineralogy. Rue-dunan, where we landed, after leaving Canna, is fituated at the bottom of the Cullin mountains, and at the head of loch Brittle. The mountains rife here, with the utmoft grandeur; but the continual covering of clouds, prevented me from inveftigating them with fo much accuracy as I wifhed. I found, that the fides of the loch, and the lower part of thefe mountains, were compofed of bafalt; but the fuperior parts, appeared to be wholly of fienite and hornblende rock, traverfed by bafalt veins. The faces of the mountains were bare, fteep, and rugged, and were much traverfed by open fiffures. In fome places, I obferved the brows of the hills covered with hornblende rock, which, by its brown colour, had

had much the appearance of the ferpentine rocks in the ifland of Unft in Shetland.

Having taken a flight view of thefe mountains, we intended to proceed to Talyfker, as being a central fpot for the inveftigation which we propofed of the coaft of Skye, from Ruedunan to Dunvegan-head; but, in this, we were difappointed, as the worthy Col. M'Leod of Talyfker, to whofe attention we were recommended, died on the very day on which we landed upon the ifland. We were now glad to take fhelter in the firft houfe we came to, and luckily, we met with an obliging man, the fhepherd to a gentleman in the army; he lodged us comfortably in his mafter's almoft wafte manfion-houfe; but we foon wearied of this retirement, and fet out for Grule, at the head of loch Eynort, where, we were informed, the minifter of the parifh refided. The path led us through a hilly country, which, as far as I examined, appeared to be compofed of bafalt and wacken; and both contained fibrous, and varioufly cryftallifed zeolite. At Grule, we waited upon Mr Macleod, the minifter, to whom we were entire ftrangers, yet he gave us a moft kind reception, and the next day accompanied us near to the valley of Talysker; but we found no variety of rocks, the whole being compofed of bafalt or wacken; at little Breeze hill, which is near to the vale of Talysker, there is a pretty

colonade of basalt pillars, which, Mr Pennant, in his voyage to the Hebrides, erroneously mentions as the most northern groupe of columns in Scotland. As the weather was very stormy, we remained with our good host for three days, but on the fourth, our anxiety to proceed on our journey, overcame every obstacle; and we left, with regret, Mr Macleod's hospitable cottage. Upon gaining the upper part of the glen, the rain and mist increased, and prevented us from having a view of many parts of the country. We continued our journey among basaltic hills, until we found ourselves on the side of Loch Harpart, an arm of the sea, which is of considerable extent, and bounded upon both sides by low basaltic hills. From this we walked on to Loch Bracadale, another arm of the sea, in which we observed several small islands, which were all apparently basaltic; as is also the case with the neighbouring country. As the storm had somewhat abated, the remainder of our walk to Dunvegan, the bleak seat of General M'Leod, was not so disagreeable: we, however, observed no variety of strata, as the the same basaltic rock still predominated; but at a distance we remarked several truncated hills of considerable height; and two of them, called Macleod's Tables, are said to have a considerable resemblance to Table Mountain at the Cape of Good Hope.——At Dunvegan there is a loch of considerable extent, which is bounded on both sides by low hills, apparently compofed

compofed of bafalt and wacken; and there are difperfed thro' it feveral fmall iflands, which, from their terraced appearance, feem alfo bafaltic. We were informed that coal had been worked near Dunvegan, but the ftratum was fo fmall that it was foon given up. Pieces of wood have been alfo found in the rocks upon the fide of the loch; probably in a breccia refembling that of the rock at the ifland of Canna.

Although I had no opportunity of examining the rocks upon the fhore which extends from Rue-dunan to Dunvegan head; yet, from the bafaltic nature of the country near it, and the general appearance of the coaft, as feen from the ifland of Canna, I have little hefitation in faying, that the general rocks will be found bafalt and wacken. It is probable, however, that this extent of country may contain many curious fporadic foffils; and veins or ftrata of pitchftone may alfo be obferved.

We now walked to Kingfburgh, by the end of Loch-Bay and Loch-Grifornifh, through immenfe tracks of peat. The neighbouring hills are low; but the rocks upon the fides, and at the mouth of the lochs, are often of great height, and very rugged and broken. I faw no variety of foffils; the whole country, fo far as the peat and heather would allow me to exmine, being of bafalt and wacken.

We remained at Kingfburgh for fome days, waiting the return of Mr Campbell, who had gone upon a fifhing expedition; but in the meantime I examined the neighbouring country. It proved to be little interefting, as it was entirely formed of ftrata of bafalt and wacken, which contained beautiful fibrous and cryftallifed zeolite, and both kinds of ftrata were frequently traverfed by bafalt veins. The old houfe, in which Mr Campbell at this time lodged, is remarkable for having afforded fhelter to Prince Charles, when purfued by the king's troops; and the fhore is noted in hiftory as the place where King James V. landed when he was making the tour of his kingdom. Mr Campbell having returned, we got the neceffary inftructions for our route to the north part of the ifland, for which we fet off next day. After leaving Kingfburgh, we walked for a mile or two along the fide of Loch-Snizort, through a bafalt country, until we reached the mill which is fituated upon a ftream of water at the head of Loch-Uig. A confiderable way above this mill there is a pretty large cafcade, formed by the water which collects from the neighbouring bafaltic hills; and near it we obferved appearances of coal. The firft was upon the fide of the ftream in the face of a fteep rock: the coal was only a few inches thick, and covered by a ftratum of bafalt at leaft 30 feet high. Immediately at the fide of the cafcade there is another fmall ftratum of coal, a few inches thick, and lying in the

the bafalt. Thefe feams, or ftrata, however, are fo ill-fituated, and fo trifling, as to be unworthy of any confideration in an economical point of view. Near to the cafcade there is a confiderable ftratum of wacken, which is covered by bafalt, and traverfed by bafaltic veins: it contains nodules and ftratulæ of fteatites, or foap-rock.

After croffing this ftream, we came to a good road, which led us to the top of a bafalt hill; and by continuing our walk for a quarter of an hour longer, we came in fight of the low, flat part of the ifland, to which we defcended by a winding road. This flat is much expofed on all fides, excepting on the fouth, where it is defended by the lofty cliffs, which are the termination of the hilly grounds of Skye, and alfo form the boundary between this part of the parifh of Kilmuir and the other parts of Skye. It appears very certain that this flat, at fome diftant period, was of an equal height with the adjacent mountains; but probably the violent agitations which took place at the Deluge, or fome very remote period, may have either fweeped away the land which is here a-wanting, or violent earthquakes may have funk it nearly to its prefent level. It could not have been carried away by the flow action of the fea, as there are no marks of the fea having lately covered it; nor can

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we fuppofe that the combined meteoric influences could, in any length of time, have produced this appearance.

The moft prevalent rock of this flat is bafalt; but upon the fhore I obferved fome variety of ftrata, of which I fhall now give a fhort account. Upon the fhore, near to the houfe of Mr Martin, the minifter of the parifh, there are cliffs of moderate height, where the lowermoft ftratum is bafalt: above this is a ftratum of blue fhiftofe clay; then a ftratum of bluifh-coloured limeftone, a foot and a half wide; and above this is another ftratum of blue fhiftofe clay. At fome little diftance from this, I obferved ftrata of compact blue limeftone, which are from 8 to 14 inches thick, alternating with layers of black-coloured fhiftofe clay, and both are traverfed by bafalt veins. To the weftward of this the ftrata are arranged in the following manner—

1. Lowermoft ftratum, compofed of bafalt.
2. Blue-coloured fhiftofe clay.
3. Argillaceous fandftone.
4. Blue-coloured fhiftofe clay.
5. This rock differs from the fhiftofe clay, in wanting the fhiftofe fracture, and being fo hard as not to be touched by the knife.

6. Blue

6. Blue ſhiſtoſe clay. This rock is ſometimes very compact, and approaches to the nature of Lydian ſtone.
7. Sandſtone.
8. Shiſtoſe clay.
9. Baſalt, which forms the upper ſtratum.

Theſe ſtrata are in general very thin, being from 4 to 12 or 14 inches thick; but the uppermoſt ſtratum, the baſalt, is of vaſtly greater thickneſs.

We now walked along the coaſt towards Duntulme Caſtle, but obſerved no variety of ſtrata beſides what we have now mentioned: the gradual breaking-down of the rocks formed, however, a ſtriking object. In ſome places, the ground on the top of the high cliffs was to be obſerved rent for ſeveral hundred feet, only waiting the effects of froſt to ſeparate maſſes of vaſt magnitude. Many ſuch maſſes were ſeen near to the ſhore; and it was pleaſing to obſerve how nature, by the breaking-down of theſe maſſes, and covering them with vegetation, has formed many ſmall, green hills, which gradually become uſeful to man, and hide the rude and broken appearance of the country. Some hundred yards from Duntulme Caſtle, I obſerved a ſtratum of ſhelly limeſtone, about 6 feet thick, reſting upon a thin layer of ſhiſtoſe clay, which again lies upon a ſandſtone.

It

It is remarkable that this limeftone contains pieces of wood flightly carbonated, being in a far lefs altered ftate than the wood found in the bafalt tuff of the rock at Canna. At a little diftance from thefe, but nearer to Duntulme, I obferved three fingular patches of Lydian ftone, which, from their black colour and glimmering luftre, are, at a diftance, much like black pitchftone. Thefe maffes, which are the remains of a ftratum that has been broke away by the fea, lie upon blue-coloured limeftone, and appear to be covered with fandftone: but I am not quite certain as to this latter fact. Thefe ftrata are traverfed by two bafaltic veins, which crofs each other, in fuch a manner, that the Lydian ftone, at firft fight, feems inclofed in a bafaltic hollow. At Duntulme, formerly the feat of the Macdonalds, the cliffs, upon which the ruins of the caftle are perched, are of confiderable height, and feem to confift principally of bafalt. Mr Pennant remarks that in thefe cliffs there are numerous fmall compreffed ammonitæ *. It is to be regretted that he has not mentioned, whether it was really the bafalt in which they were immerfed, or rather a ftratum of limeftone: the latter, to me, feems more probable.

As

* Pennant's Tour in Scotland, and Voyage to the Hebrides, p. 304.

As we proceed towards the north point of the iſland, the coaſt becomes high and rocky: the cliffs are ſeen to have been torn aſunder, and great maſſes project in terrific grandeur from their tops. Upon the moſt northern point, the rocks are precipitous, and of great height. In one part they are particularly grand: we were upon the ſummit, and the burning of the kelp below enveloped their baſe in murky darkneſs, while the waves, broken into irregular points, were indiſtinctly ſeen laſhed into foam. From this, looking northwards, the point of the Lewis retires beautifully into a low track of land; and, towards the eaſt, the mainland melts into the horizon, and at laſt is diſtinguiſhed only by the fleecy clouds that are attracted by it. Such an appearance muſt be grateful to the ſailor, when his eye has been long fatigued with the weary ſameneſs of the ocean, before land is perceptible, it is known by the appearance of the clouds on the horizon.

We now walked through a conſiderable extent of country to Loch Staflin, which is ſituated upon the eaſt coaſt of the iſland; but in this track I obſerved no other rocks beſides baſalt and wacken, which are in ſome places traverſed by baſaltic veins. At Loch Staflin, the country on the ſhore is low; but on one ſide there is a ſmall hill, which, at a diſtance, has a very reddened and burnt appearance, ſo that it may with all pro-

 priety

priety pafs for a *Scottifh* volcano : but a nearer examination difclofes its ftructure, which is an alternation of bafalt and common wacken, with red-coloured wacken. The quantity of this red wacken is very great; indeed more fo than I have obferved in any other part of the Hebrides. At fome diftance from the fhore we obferved a range of hills, which rife from the low part of Kilmuir parifh, and, we were told, extend to Portree. Thefe hills, which appear entirely bafaltic, are here much broken; and the feparated maffes are to be feen gradually mouldering down, and at length covered with vegetation. If we examine this breaking-down of the land with more attention, we fhall find a beautiful progreffion. Firft, we obferve immenfe maffes, which, by their vicinity to the cliffs, and their peaked form, indicate that they have been lately rent from the mountain. At fome diftance, other maffes are to be feen, where the fharp, peaked form is worn away, and now they have a flat and rounded form, and are partly furrounded by debris. Still nearer the fea, the maffes difappear under the covering of debris; and now vegetation makes its appearance, which increafes more as we come to the flatter parts of the country. At a little diftance from Loch-Staflin we obferved a beautiful frefh-water lake, called Shiant, or The Sacred Lake. Its banks are covered with natural wood, and it is filled by numerous fprings; fo that its water is cool, clear, and refrefhing. It has not

not efcaped the particular regard of the inhabitants, who formerly frequented it in great numbers, as it was reckoned facred, and capable of healing all difeafes. From this loch we walked for a fhort way through corn fields, and then along a dreary moor, which was bounded, upon one fide, by the range of hills which extend to Portree, and, upon the other, by the ocean, and the diftant mountains of the mainland of Scotland. The filence of the fcene was broken only by founds which rendered it more difmal—the mournful whiftle of the plover, or the wild notes of the curlew; while the fullen roar of the ocean came at intervals upon the ear, as it heaved its mighty furges on the fhore. The day, which was for fome time extremely delightful, began to lour, the wind arofe, and we faw the clouds gathering upon the neighbouring mountains. To avoid the coming ftorm, we haftened to pafs the muir, that we might reach the path which leads acrofs the mountains. After a journey of feveral hours, we came to the bottom of the mountains: they were enveloped in clouds, and the rain was falling in torrents. Fatigued by a long march, and with our clothes wet and clinging about us, we had ftill the fteep afcent of the mountains, which divide the northern part of the ifland, before us. We began to afcend, and perfevered in climbing againft the blaft: the long heather, and the wetnefs of the ground, encreafed our toil; but at laft we gained a confiderable plain.

Sometimes we were involved in impenetrable mifts; but we could look back, at intervals, upon the plain country we had left, ftill partially illumined by the fun, and fmiling faintly through the veil that furrounded us. As we continued to afcend, the thicknefs of the mift was terrible. Our guide began to talk ferioufly of his doubts and fears; affuring us that frequently people, going in fearch of cattle among the mountains, were overtaken by thefe mifts, and forced to fit quietly down, and wait for the morning. The fituation forcibly impreffed us with the truth of what he related; and we entered with a lively fympathy into the anxiety and defpair, and vain ftruggles, of thofe who are left thus to wander alone. While we went mufing on our fituation, and indulging in imaginary diftreffes, our guide pointed to the cairn of a poor fhepherd who had perifhed in the fnow. It was the very fcene that Thomfon muft have painted,

> Where many hills afcend, of unknown, joylefs brow;
> And many fcenes of horrid profpect rife.

We could fancy we faw the unhappy man, with defperate effort, hurrying through the wafte,

> From hill to dale ftill more and more aftray,
> Impatient—through the drifted heaps,
> Stung with the thoughts of home: the thoughts of home

Burft

Burſt on his nerves, and call their vigour forth
In many a vain attempt——till down he ſinks
Beneath the ſhelter of the ſhapeleſs waſte,
Thinking o'er all the bitterneſs of death.

Having contemplated the unhappy fate of this poor ſhepherd, we paid the tribute of a ſtone to his cairn, and paſſed on. We found a narrow ſheep-track, by which we ſcrambled upwards, but the torrents of water which were daſhing upon all ſides, rendered the aſcent very fatiguing, and ſometimes dangerous. At length we reached the ſummit, from which we were glad to deſcend quickly towards the low country. About half way down the mountain, the clouds appeared clearer, the rain was leſs violent, and ſuddenly, as by enchantment, we burſt from clouds, and ſaw the country ſmiling below us. When we deſcended from the mountain the ſun was ſetting; the evening was placid and ſerene; all the landſcape was "mellowed by the gradual duſky veil." We now walked onwards when our fatigues were forgotten in the pleaſures of the hoſpitable family of Kingſburgh.

This tract of country over which we had paſſed, appeared to be entirely compoſed of baſalt and wacken. We now paſſed a few days at Kingſburgh, and then left with much regret

a family,

a family, to whofe extreme kindnefs and hofpitality, we had been fo much indebted, during our ftay in this part of the ifland.

Mr Campbell, who was going to the fouth part of Skye, accompanied us to Portree. The hills in this direction are not of great height; but as we approach Portree, they become higher, and upon the fummit of one of them there is faid to be the *crater of a volcano*, where probably there may be ftill fufficient heat to revive the drooping fpirits of fome forlorn fire philofopher as he wanders through this cold, bleak country. The ftrata are either bafalt or wacken; and the latter often contains a very great quantity of zeolite, indeed fometimes it forms nearly one half of the ftone.

Portree is a harbour of confiderable extent, and capable of admitting veffels of fome burden; it is befides very fafe, as it is well defended by the ifland of Rafa, from which it is only about three miles diftant. Here there is a confiderable thorough fare; and as it is the principal market place in the ifland, of courfe there is an inn. There are in the Highlands, as in other countries, places where ftrangers find bad accommodation; but certainly the inn of Portree has feldom been equalled for dirtinefs: a traveller from among the Hottentots might

might well recognife the *Kraal*, although fo far removed from its cuftomary fituation. Upon the north fide of the harbour, there are rocky cliffs, which increafe in height from the inn to the entrance of the harbour, where they are very bold and ftriking. Near to the inn, the cliffs are formed of a reddifh coloured argillaceous rock, which is much of the nature of fandftone, and contains pieces of bafalt, and is alfo traverfed by bafaltic veins; but the higher cliffs prefent a fandftone which contains numerous petrefactions, and alternates with bafalt. This alternation of fandftone probably continues all along the fhore to the muir near Loch Stafling. Upon the fouth fide of the harbour I obferved a ftratum of coal, from one to two feet wide, refting on bafalt, and covered by a fimilar mafs from 16 to 20 feet high. In the coal I faw feveral pieces of carbonated wood, which could not poffibly be diftinguifhed from pieces of common carbonifed fir. This does not feem to be a common appearance, for Emmerling only relates two inftances, the one obferved by Dr Reufs, the other by Mr Flurl. As we approach the mouth of the harbour on this oppofite fide, the cliffs rife to a great height, and are compofed of fandftone and bafalt, which alternate; and the bafalt, from its being the leaft deftructible, feemed always to form the higher and more expofed parts. The fandftone at a diftance has the appearance of a breccia compofed of great rounded

maffes,

maffes, but upon a nearer examination, I was furprifed to find it in large oval or globular fhaped maffes, as is the cafe with many kinds of bafalt, and fome kinds of granite.

This appears alfo to be a rare phenomenon in other countries, as I find it only mentioned by Dr Reufs, who obferved globular fandftone in the Bunzlauer circle in Bohemia*. Having procured a boat, we failed along the coaft to Kaimifkianeveg, where we were told that coal had been difcovered. The coaft all the way is apparently fandftone and bafalt, being a continuation of the ftrata from the fouth fide of Portree harbour. Having landed, I obferved in a cliff, about 40 feet above the level of the fea, a ftratum of coal, covered by bafalt, but unluckily the whole cliff was fo concealed with vegetation, that neither the extent nor direction of the coal could be difcovered. Nearly at the bottom of this cliff I obferved a great ftratum of the common argillaceous fandftone, and part of it was globular, like that at the harbour of Portree. From this towards Sconfer the cliffs are in general lower, but the fandftone is not now to be feen, bafaltic cliffs, as far as I examined, appearing to bound the coaft. I cannot omit mentioning another appearance of coal, which I examined upon the coaft oppofite

* Reufs mineralogifche geographie von Boehmen. B. 2. 45.

oppofite to Clachan in the ifland of Rafay. It is a feam of coal about two inches wide, and vifible for about 30 feet, but it is waved in its courfe. The upper and lower fides are bounded by fhiftofe clay. Above this clay there is a thin ftratum of Lydian ftone, and this is again covered by great cliffs of bafalt. From this the bafaltic rock continues nearly to Sconfer, where the high mountains connected with the Cullin groupe, now make their appearance immediately on the fhore. Above the poft-houfe of Sconfer, rifes the high hill of Glamofcard, which we afcended in order to have a view of the Cullin mountains from this fide of the ifland. The fhore and lower part of the mountain is formed of red coloured argillaceous fandftone: to this fucceeds a more compact and nearly filiceous fandftone, but it continues only for a fhort way, for as the mountain becomes fteeper, we find it formed of great ftrata of porphyry and wacken, and both are traverfed by bafalt veins. Thefe ftrata continue to the fummit of the hill, which has a burnt or reddifh brown colour, owing to the cover of decompofed porphyry. The neighbouring mountains, as feen from this elevation, feem to rife to a great height, and are feparated from each other by extenfive vallies, which have a ftriking appearance, owing to the red colour of the bounding mountains. In defcending, we were obliged to take the lea-fide of the mountain on account of the violent wind; this was a fortu-

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nate accident, for while walking in this direction, I obferved numerous fragments of yellowifh, and green coloured pitchftone. This was to me an interefting fact, as I had never before obferved pitchftone among porphyritic rocks: I therefore examined all around very carefully, in order to difcover if poffible whether it was difpofed in ftrata or veins. I was not fo fortunate, however, as to determine this point, on account of the great covering of debris; yet I am inclined to fufpect that it is difpofed either in very thin ftrata, or in veins, as the quantity of debris feemed too fmall, for fuppofing that great ftrata exifted near this fpot. As the determination of the geognoftic relations of this foffil, is an object of much confequence, I would earneftly recommend a careful examination of this mountain to future travellers. To do this at fufficient leifure, it will be convenient to fpend fome days at Sconfer, and from this to examine Glamafcard, and the neighbouring mountains, where moft certainly they will be able to difcover the relative pofition of the pitchftone to the other rocks. To affift in this inveftigation, I may mention that pitchftone has been found among fimilar rocks in different parts of Europe; thus in Mifnia, great ftrata of pitchftone, are obferved alternating with porphyry *. Efmark, a well informed pupil of Mr Werner, defcribes

* Emmerling Mineralogie.

describes it as alternating with porphyry in Hungary ‡; and Voight found it at the foot of Schneekops in the forest of Thuringia, among rocks of porphyry, but he does not mention whether it was in strata or veins.

From Sconser to Broadford we sailed along the shore thro' the sound formed by the islands of Rasay and Scalpa, which was bounded on one side by lofty magnificent mountains. These hills, as far as the weather would permit me to examine, appeared to be composed of porphyry; and upon the shore, in place of the basalt and sandstone, was formed a compound of felspar and quartz, or what may be called granitel, which pears to rest on limestone, and is traversed by basalt veins. At Broadford, the shore is very low, and continues so to the Kyles of Skye; the country is pretty flat, affording an agreeable scene after so long wandering among mountainous ruggedness. From Broadford to Cory, the country is low, but is bounded upon both sides by hills, thus forming an irregular valley, which extends to Loch Slepin, upon the opposite side of the island. The low part of the valley, appeared to be principally composed of the above-mentioned granitel; which, as is the case with the other, sometimes contains a little chlorite; and in other instances, seems passing to porphyry. Upon one side, there is a

‡ Newes Bergmanisches journal.

range of blue limeſtone hills, which riſe from the ſhore at Broadford, and continue increaſing in height to Suwardel, which is the higheſt part; whence they run in an irregular manner towards Loch Slepin. This limeſtone, which is of a blue colour, is in many places traverſed by baſalt veins, which are often of great ſize, and run in different directions. Upon the oppoſite ſide of the valley, Ben-na-callich and the neighbouring mountains, form a tremendouſly ſublime boundary. As our time would not allow us to examine all theſe mountains, we agreed to aſcend Ben-na-callich; we did this the more readily, as we knew from Mr Pennant, that from its ſummit, there was a vaſt diſplay of mountainous ſcenery. After leaving the houſe of Cory, on our way up the mountain, the firſt object which attracted our attention, was a fine white calcareous marle, which forms a bed of conſiderable thickneſs. Upon examining particularly, I obſerved mixed with it, maſſes of white and grey marble; and theſe were ſeen in all the ſtages of decompoſition, until they formed a ſubſtance not diſtinguiſhable from the marle. This fact renders it probable, that the whole bed is formed by the debris which has been waſhed from the neighbouring marble ſtrata. As we continued our aſcent, the mountains became more ſteep, and we obſerved the crop of blue and white coloured marble, which formed a ſtriking contraſt with the brown burnt-like

aſpect

aſpect of the heath. As I could not at this place diſcover how theſe marble ſtrata were diſpoſed, I deſcended into one of the numerous ravines which furrow the ſide of the mountain, where we judged it probable that their poſition might be determined. The bottom of the ravine was formed of white marble; but upon the ſides, I obſerved rocks different from any which had been ſeen in the other parts of the iſland; but unluckily, they were ſo diſcompoſed and covered with debris, that I could neither determine their ſituation with regard to the marble, nor their particular nature. I therefore continued my examination along the ravine, until I diſcovered the marble covered with a ſtratum of hornblende rock, which had much the appearance of baſalt: and higher up the mountain, in another ravine, it appeared nearly in contact with a granitel ſimilar to that which forms the bottom of the valley; but I could not determine whether there was any interpoſed hornblende rock. Beſides this hornblende rock, I alſo obſerved maſſes of greenſtone, and a porphyritic rock, which has a baſis of quartz penetrated with hornblende, and immerſed in it a few cryſtals of felſpar. This part of the mountain ſeems alſo to contain either ſtrata or veins of dark nearly leek-green-coloured pitchſtone: as I picked up ſeveral fragments that were ſcattered among the heath—As we continued aſcending, the marble diſappeared, and alſo the heather; the mountain ſide being now covered

with

with loofe ftones, which rendered our further progrefs difficult and tedious. This debris is formed by the breaking down of the granitel which forms the hill to its fummit; it is different in appearance from that of true granite, bafalt, or granulated quartz; and although it cannot be characterifed in writing, yet, an attentive examiner, is much ftruck with the peculiarity of its appearance. Amongft the debris, I obferved maffes of greenftone; but had not an opportunity of determining, whether it formed ftrata or veins. After fcrambling over this debris, which covers fo confiderable a part of the mountain, we came to a green fpot; from whence, the afcent is eafier. We now haftened with eager ftep towards the fummit, and foon reached the cairn, which is upon the moft elevated part of the mountain. Here, our moft fanguine expectations were more than realized, every faculty for a while feemed arrefted, until we could burft into an exclamation on the vaftnefs of the fcene, and on the mighty and eternal power of him who framed fo great a work. Before us, were many great vallies bounded by lofty mountains, whofe fteep fides were red, owing to the powerful influence of the elements, and furrowed by the many torrents which collect during the dreadful ftorms that often reign in thefe wilds. At a greater diftance, the dark, lurid and terrible fummits of the Cullin mountains retiring in majefty among the clouds; thus dimly feen, adding much

Engraved by R. Scott Edin.

VIEW from BEINN NA CAILLICH in SKYE.

much to the fublimity of the fcene. To the north, we obferved below us the low part of the ifland, with the ifles of Rona, Rafay, Scalpa, and Pladda : towards the eaft and fouth, the rugged mountains of the mainland appeared ftretching in all the grandeur of Alpine wildnefs to the point of Ardnamurchan; and nearer, the ifles of Eigg and Rume added to the variety of this interefting profpect.—We ftood long enraptured with the wonderful fcene; but the darkening of the fky admonifhed us to fhorten our ftay, and haften again to the valley. The clouds were now feen driving through the glens, and covering the mountains with a dark veil; foon all was loft in grand confufion; what a few minutes before was clear and diftinct, was now a troubled fcene of tremendous mountainous peaks, fhooting above the dark clouds, and reddened valleys dimly feen through the driving mift and rain. We took the lea fide of the mountain, and foon reached the houfe of Cory *.

As the weather continued ftormy, we could not accomplifh our intention of examining the mineralogy of the country about Loch Slepin, a circumftance which I regretted very much, as

* Upon the fummit of Ben-na-callich, I picked up feveral pieces of porphyry, refembling that which forms the hill above Glamofcard.

as in all probability, it would have proved very interefting. We therefore left the kind and hofpitable family of Coryhattican, to take a view of Sleat, which is the moft fouthern parifh in the ifland. Having reached Broadford, we walked through a dreary muir, to a fmall bay called Loch-in-daal, which is nearly oppofite to the wild and romantic arm of the fea, called Loch-Huron. In this tract, we walked for feveral miles over a blue-coloured limeftone, which by the action of the weather fplits into thin rhomboidal-fhaped maffes, like the fandftone we obferved near the Cock of Arran. To this fucceeds a red-coloured argillaceous fandftone, which extends nearly to Loch-in-daal, when it is fucceeded by an argillaceous breccia. This rock, however, continues only for a fhort way, when diftinct primitive rocks, as gneifs, talcaceous fhiftus, and hornblende flate, are to be obferved alternating with each other. The face of the country is now much altered in its appearance, the hills are low, and in place of brown heather, are covered with grafs, and beautiful little tufts of natural wood, with interfperfed cafcades, increafe much the beauty of the fcenery. As we proceed onwards, the country increafed much in beauty; and at Armidale, the feat of Lord Macdonald, where we terminated our journey through this ifland, there is a fweetly retired houfe and grounds, but in extremely bad order. As far as I could judge from a fhort excurfion which I made

made, ſouth from this place, the ſtrata appear to be primitive to the extremity of the iſland; and theſe are principally talcaceous ſhiſtus, hornblende ſlate, and ſometimes chlorite ſlate, and all traverſed by baſalt veins. The hornblende has ſometimes interſperſed cryſtals of actynolite.

RASAY, RONA AND SCALPA.

CHAP. XXII.

Outline of the MINERALOGY *of* RASAY, RONA, *and* SCALPA.

RASAY.

THIS iſland, which is the property of James Macleod, Eſq. is about 15 miles long, and three miles broad: it is ſeparated from the iſland of Skye by a ſound about three miles over: it is low towards both extremities, but riſes to a conſiderable height in the middle, forming the hill of Dun-can. The ſhores are in general rocky, and in ſome places the cliffs riſe to a conſiderable height; but there are no caves of any conſiderable magnitude, nor is there a harbour in the whole iſland.

MIN-

Mineralogy. The ſhore below Clachan, the pleaſant ſeat of the hoſpitable Mr Macleod, is formed of white-coloured argillaceous ſandſtone, diſpoſed in horizontal ſtrata; but as we walk towards Sweniſh, we meet with argillaceous porphyry. At Sweniſh point the porphyry appears to lie on ſandſtone, and has, in many places, an iron-brown colour, owing to the decompoſition of the iron pyrites which it contains. As we proceed towards the ſouth part of the iſland, the porphyry ſtill continues; but nearly oppoſite to Sconſer, in the iſland of Skye, I obſerved, on the ſhore, blue-coloured limeſtone cropping through the debris, and it even continues to ſome height in the neighbouring grounds. At Rue-clachan, the moſt ſouthern part of the iſland, the porphyry diſappears, a ſandſtone breccia taking its place. In this breccia, beſides the fragments of quartz, I obſerved ſmall ſtratulæ of red ſandſtone, and maſſes of a very beautiful porphyry, with a blue-coloured baſis. From this, along a conſiderable extent of the eaſt coaſt of the iſland, the cliffs are low; but, nearly oppoſite the iſland of Scalpa, they riſe to a conſiderable height, and continue ſo to Brokel Caſtle. The prevailing ſtrata in theſe cliffs are ſandſtone and breccia, which alternate. The ſandſtone has frequently a calcareous baſis, and contains numerous impreſſions of ſhells, as pectines, &c.; and ſome ſpecimens of the pectines which we obſerved were from 6 to 8 inches

long, and 4 or 5 broad. The ſandſtone, alſo, not unoften contains pieces of bituminated wood. Having reached the cliffs which are nearly below the hill of Dun-can, we aſcended by a narrow path, and ſoon arrived at the top. I obſerved no intereſting variety of rock: the ſtrata, near the ſummit, being ſandſtone, which was in ſome places very hard; and upon the ſummit there were rocks of baſalt, which had a conſiderable effect upon the compaſs. The view from this ſpot is very extenſive; but what intereſted us moſt, was, the appearance of the north end of the iſland, and the iſle of Rona, which, from their rugged, grey, ſteril aſpect, and their riſing into low, irregular hills like Coll and Tirie, ſeemed to announce a ſimilarity of compoſition. We now deſcended from this towards Brokel Caſtle, and in our courſe met with much red-coloured argillaceous ſandſtone, and in ſeveral places great maſſes of breccia. This caſtle is built upon a great rock of breccia, and is the moſt picturesque and ſtriking ruin that we had obſerved in any of the Hebrides. A few yards from the caſtle, and immediately on the ſea-ſhore, the ſecondary ſtrata are terminated, when gneiſs and hornblende-rock begin. At a little diſtance from where the ſandſtone diſappears, I was ſo lucky as to obſerve a ſtratum of breccia, compoſed of fragments of gneiſs, hornblende-rock, and quartz, lying on the gneiſs: thus ſhowing the junction of the primary with the ſecondary ſtrata. The ſtrata of gneiſs

gneifs continue to the northern extremity of the ifland, fometimes alternating with hornblende flate, and traverfed by bafalt veins: thus confirming the conjecture we had made on the top of Dun-can, that the north part of the ifland is of a fimilar compofition with the iflands of Coll and Tirie. The end of the ifland is feparated from the fmall ifland of Rona by a narrow ftrait, in which lies the ifle of Mattea, which is compofed of fimilar rocks with this part of Rafay. As we return along the weft fide, the fame kinds of rock ftill continue; but, near to the ifland of Fladda, I obferved a fmall portion of fecondary rock fkirting the primary. As the appearances prefented by the junction of the different ftrata, particularly that of the primary with the fecondary, are highly deferving of attention, I landed upon the fhore of Rafay, in the found of Fladda, to examine the fecondary ftrata I have juft mentioned. Thefe ftrata do not extend for more than 30 or 40 feet in all directions. The uppermoft ftratum is an argillite, or fheifer-thon; and, below, is a fpecies of breccia, containing fragments of hornblende flate, gneifs, quartz, and hornftone; and from under this ftratum rifes the gneifs, which forms this part of the ifland. Thefe fecondary ftrata appear formerly to have been connected with thofe in the ifland of Fladda, as it is entirely compofed of fecondary ftrata of argillite and red fandftone; and, in a more extended view,

Fladda

Fladda appears to have formed a part of the ſtrata which formerly joined with the ſandſtone-cliffs upon the ſhore of Skye. After leaving this junction, the coaſt continues formed of the uſual gneiſs, &c. until we come to Loch-Arniſh, where I obſerved great ſtrata of breccia covering the gneiſs. Nothing curious again occurred, until we landed upon that part of the iſland, which is, I think, about due W. from the caſtle: here the gneiſs is covered with breccia, and the breccia is covered with red-coloured argillaceous ſandſtone ſimilar to that obſerved near Brokel Caſtle. From theſe obſervations, it appears that the primitive rock occupies that part of the iſland which is included in the ſpace marked A, in the map.

The red ſandſtone, which I have now mentioned, is elevated at an angle of 45°, and dips to the W. and continues for ſome miles, forming low ſhelving ſhores, or high cliffs; and as it riſes into the interior of the iſland, the extenſive, bare, expoſed ſurface of the red ſandſtone has a ſtriking appearance. As we proceed along the ſhore, we find it ſucceeded by white-coloured ſandſtone; but this continues but for a ſhort way: as, nearly oppoſite to Portree harbour, felſpar-porphyry makes its appearance, forming low cliffs upon the ſhore, or riſing upwards to within 30 or 40 feet of the ſummit of Dun-can, thus forming the weſt ſide, as the ſandſtone does the eaſt. It continues

alſo

alſo to form the rocks upon the ſhore, and the hills, until we come within half a mile of Clachan, where baſalt rocks begin, and continue nearly to Mr Macleod's houſe. This baſalt does not riſe to any conſiderable height, and the porphyry is to be ſeen riſing from under it; but I was not ſo fortunate as to obſerve their junction.

The whole of the porphyry is evidently of ſecondary formation, as it does not extend beyond the line A, which I have before mentioned as the boundary between the primary and ſecondary ſtrata. It ſeems to form the baſis of the ſouth part of the iſland; and it is probably covered by the ſandſtone and baſalt, or they may alternate with each other. A diſpoſition of ſtrata, pretty nearly ſimilar, has been obſerved in other parts: thus, Kohler, in the Miner's Kalendar for 1790, obſerves, that ſandſtone and porphyry are ſometimes connected together, and it is then of ſecondary formation; and, in the iſland of Arran, we have already obſerved porphyry reſting upon ſandſtone.

RONA.

RONA.

THIS iſland, which is alſo the property of James Macleod, Eſq. of Raſay, is about four miles long, and ſeparated from Raſay, as I have before mentioned, by a narrow channel. It is bare and rugged, and riſes into irregular hills, like thoſe in the north part of Raſay: the ſhores are rocky and dangerous, and there is no harbour.

Mineralogy. The ſtrata, in general, do not differ much from thoſe that form the north end of Raſay; being an alternation of gneiſs, micaceous ſhiſtus, and hornblende-rock. Many granite veins are to be obſerved traverſing theſe ſtrata in different directions, and they are from one foot to ten feet wide. They are to be diſtinguiſhed at a conſiderable diſtance; not only by their running in a croſs direction to the ſtrata, but alſo, by reaſon of the great ſize of the cryſtals of felſpar, which are ſometimes 12 inches long. The only other appearance of conſequence, which I had an opportunity of examining, was at Tuhumas

Tuhumas, or Blue-Bay: here there is a mafs of rock, which is compofed of chalcedony, hornftone, and quartz, from 12 to 15 feet wide, and extending for a long way, and bounded on both fides by gneifs. I regret that I had not fufficient leifure to determine with certainty whether it forms a ftratum or a vein: the determination of this point, however, is well deferving the attention of mineralogifts who may vifit this ifland.

SCALPA.

THIS fmall ifland, which is the property of Lord Macdonald, is about 2½ miles long, and 1 mile broad: it is hilly, and the fhores are low.

Mineralogy. At Mr Macdonald's houfe, the fhore is low, and is formed of blackifh-coloured argillaceous fandftone, which contains numerous impreffions of fhells and zoophytes. This fandftone, with an alternation of limeftone, continues to the northern extremity of the ifland: here, however, a red-coloured fandftone, alternating with common fandftone-brec-

cia, makes its appearance, and continues around the whole eaſt and ſouth ſides of the iſland, until we again come to Mr Macdonald's. The higher parts of the iſland are entirely compoſed of a granitel ſimilar to that of Ben-na-cailigh; but I could not determine its ſituation with regard to the ſandſtone: it is probable, that the ſandſtone covers it.

SKYE,

SKYE, RASAY AND RONA.

CHAP. XXIII.

Defcription of the FOSSILS *mentioned in the preceding Chapters.*

SIENITE—*Cullin Mountains*, *above Rue-dunan.*

The fienite of thefe mountains, like that of the ifland of Arran, is fmall-grained, and extremely compact, and alfo varies much in the proportion of its conftituent parts. I fhall not now give any more particular defcription, as it would be pretty nearly a repetition of what I mentioned when defcribing that of Arran; and have only to mention, that we frequently meet with beautiful nefts of glaffy actynolite difperfed through it.

WACKEN—*Uig Mill Water.*

This has the common character of wacken; but it has, interfperfed, balls of calcareous fpar, zeolite, and foap-rock, both in balls and irregular pieces.

The SOAP-ROCK, or STEATITES, has the following characters—

Colour. White, greenifh white, dark green, and fometimes brown and blue.

Luftre. None.

Tranfparency. Allows light to pafs freely through the edges, but is alfo fometimes nearly opaque.

Fracture. Fine fplintery.

Hardnefs. Scrapes eafily with the nail.

Trace—upon paper, is glimmering, and takes a polifh with the nail; and feels greafy.

The white kind is marked by dendritical figures, and is the fame with the chalk of Briancon, and, intermixed with it, are frequently beautiful white fibrous zeolites. It is ufed in Corn-

wall

wall for the making of porcelain; and were it found in confiderable quantity in Skye, might alfo be of confiderable value.

At a meeting of the Electoral Academy of the Ufeful Sciences at Erfurt, C. A. M. Baron Von Dalberg read a paper on fteatites, in which he fhewed, that, when cut into figures, and then burnt in a clofe veffel, it acquires a hardnefs that will refift the file. He alfo related a feries of experiments he had made, on the method of giving a durable dye to hardened fteatites; by which it appears, that it may be made to imitate the moft efteemed and beautiful kinds of ftone. In the fpecimens laid before the Society, the hardened fteatites had taken a very remarkable degree of polifh, and the heads that were cut on it were very beautiful.

LYDIAN STONE, *which covers the Coal, in Skye, oppofite to Clachan, in Rafay.*

Colour. Black.
Luftre. Faintly glimmering.
Tranfparency. None.
Hardnefs. Gives fire very plentifully with fteel.
Fracture. Uneven, with a tendency to the conchoidal.

This

This ſtone is deſcribed by Pliny, who mentions that it is found in great plenty in Lydia, in the leſſer Aſia. It was much uſed by the antients as a touchſtone for trying the purity of gold or ſilver. It is now known, however, that any ſtone, which has a black colour, and a ſufficient degree of hardneſs, will anſwer equally well.

SHISTOSE CLAY, *which covers the Lydian Stone.*

Colour. Black.
Luſtre and Tranſparency. None.
Fracture. Even; in the groſs, ſlaty.
Hardneſs. Yields with difficulty to the knife.
Streak. Dark-brown.

PORPHYRY—*Hill of Glamoſcard, Skye.*

This porphyry has, in ſome inſtances, a baſe of hornſtone; in others, has more the appearance of indurated clay. It has cryſtals of white and red felſpar, and alſo quartz, diſperſed thro' it. By decompoſition, it becomes white, and ſometimes brown.

PITCH-

PITCHSTONE—*Hill of Glamoſcard, Skye.*

Colour. Dark reſin-brown.

Luſtre. Reſiny, and nearly ſtrong glancing.

Tranſparency. Tranſmits light at the edges; but, in thin pieces, it is ſemi-tranſparent, and has a fine amber colour.

Fracture. Uneven, and conchoidal.

Hardneſs. Does not yield to the knife, and gives a few ſparks with ſteel.

Interſperſed there are a few cryſtals, which appear to be felſpar.

Blackiſh-green PITCHSTONE—*Hill of Glamoſcard, Skye.*

Colour. Light blackiſh-green.

Luſtre. Waxy.

Tranſparency. None.

Fracture. Uneven, with a number of rounded, diſtinct concretions: in the groſs, it is frequently ſhiſtoſe.

Hardneſs. Gives fire very difficultly with ſteel.

Has, diſperſed, a few cryſtals of white felſpar.

In

In ſome ſpecimens this Pitchſtone has the following characters—

Colour. Pretty dark blackiſh-green.
Luſtre. None, or extremely little.
Tranſparency. None.
Fracture. Even, with a tendency to conchoidal.
Hardneſs. Gives fire plentifully with ſteel.

It is alternated with layers of a whitiſh-coloured ſubſtance which reſembles hornſtone, and a few cryſtals of felſpar are diſperſed through it. This ſeems to be one of the links of a gradation to hornſtone, or ſome ſimilar rock.

WACKEN, *which alternates with the Porphyry, upon the Hill of Glamoſcard, Skye.*

Colour. Light greeniſh-grey.
Luſtre and Tranſparency. None.
Hardneſs. Yields rather with difficulty to the knife.
Streak. Light grey.
Smell. Strong earthy.

It

It contains frequently yellowiſh-green coloured cryſtals, probably actynolite, and ſometimes reddiſh cryſtals of felſpar.

GRANITEL.

Saxum Morensi, Lin. *Granites Simplex*, Gmelin. *Halb Granit*, Germanor.

This rock, which forms the upper part of Ben-na-cailich, in Skye, is compoſed of white-coloured felſpar, and quartz; and, intermixed, there are a few dark-green points, which appear to be chlorite. Iron pyrites is ſometimes obſerved; and this, by decompoſition, gives a reddiſh tinge to the mountains.

MARBLE—*Cory*, *Skye*.

1ſt Species.

Colour. White, and veined with aſh-grey.

Luſtre. None.

Tranſparency. Tranſmits light at the edges.

Fracture. Even, fine ſplintery.

Hardneſs. Yields with ſome difficulty to the knife.

It is very heavy; and, by expoſure to the air, it waſhes down into a powder, and forms calcareous marle.

2*d* Species.

Colour. Aſh-grey.

Luſtre. Has a ſlight degree of luſtre, from a number of very minute foliæ.

Tranſparency. Tranſmits very little light at the edges.

Fracture. Coarſe ſplintery.

Hardneſs. Yields pretty eaſily to the knife.

It feels very heavy; and is variegated by beautiful citron-yellow coloured ſtripes, which traverſe it in different directions. Theſe yellow ſtripes ſeem to be owing to an intimate combination of chlorite, or hornblende, with the marble.

3*d* Spe-

3*d* Species.

Colour. Snow-white.

Lustre. None; or extremely little, from very minute foliæ.

Transparency. Transmits light at the edges.

Fracture. Even, or very minutely granularly foliated.

Hardness. Yields pretty easily to the knife.

Feels very heavy. Sometimes it has a brecciated appearance, from its containing masses of marble of a harder texture. By the action of the weather, it decomposes, and forms a marl.

4*th* Species.

Colour. Pure white, mixed with bluish grey.

Lustre. Pretty considerable, from the number of foliæ.

Transparency. Allows light to pass at the edges.

Fracture. Granularly foliated.

Hardness. Yields pretty easily to the knife.

This species differs from the fine marble of Carrara, only in the slight admixture of the bluish-grey colour.

 FELSPAR

FELSPAR PORPHYRY—*Rafay.*

This porphyry has a bafis which is compofed of minute cryftals or grains of felfpar and quartz, with generally a few fpecks of hornblende or chlorite; and in this bafis there appear pretty large cryftals of reddifh or white-coloured felfpar, and fometimes cryftals of quartz. Often it is merely a compound of cryftals of felfpar and quartz, forming a ftone like that of Benna-cailich in Skye. This porphyry differs from the fienite-porphyry of Werner, in containing a greater proportion of felfpar, and comparatively little hornblende. Efmark * informs us, that the Schemnitz and Cremnitz mining-fields, in Hungary, are fituated in fienite-porphyry; and alfo, that he obferved it alternating and paffing into clay-porphyry. This latter fact fhows us that fimilar alternations and gradations may be difcovered in Rafay; as I remarked clay-porphyry, in feveral parts of the ifland, intermixed with the felfpar-porphyry.

Indigo-

* Neues Bergmannifches Journal, bande 1, 2.

Indigo-blue coloured HORNSTONE PORPHYRY—*Rasay.*

Colour. Pretty dark indigo-blue (hoch indig blau).
Lustre and Transparency. None.
Fracture. Even, with a tendency to the conchoidal.
Hardness. Strikes fire very plentifully with steel.
Smell. Faint earthy.

It has, dispersed through it, yellowish-coloured crystals of felspar, and also quartz of the same colour, which is sometimes in the form of six-sided pyramids. This beautiful species of porphyry seems to be intermediate between clay and hornstone-porphyry, but, by reason of its hardness, it is more of the nature of hornstone.

CHALCEDONY—*Rona.*

Colour. Grey, brown, or greenish.
Lustre. Glimmering, with a greasy lustre.
Transparency. Allows light to pass easily through it.

Fracture.

Fracture. Compact; ſometimes paſſing to the ſplintery.

Hardneſs. Gives fire with ſteel more plentifully than flint.

It is ſometimes intermixed with the gneiſs, in which it lies; and very thin ſtripes of a yellow and white-coloured ſubſtance alternate with it: ſo that, at firſt ſight, ſuch ſpecimens are not unlike petrified wood.

CHALCEDONY, penetrated with Hornblende—*Rona.*

Colour. Siſkin-green, of various ſhades; and ſometimes dark leek, or mountain green.

Luſtre. None, or hardly perceptible glimmering.

Tranſparency. It has more or leſs tranſparency, according to the intenſity of the green colour. If the colour is very pale, the tranſparency does not differ from common chalcedony; but as the colour approaches to dark leek-green, it becomes leſs tranſparent, until it is quite opaque.

Fracture. Compact, even, and ſometimes ſplintery.

Hardneſs. Is much the ſame with chalcedony, excepting when much hornblende is combined, when it is ſomewhat ſofter, and has a greater ſpecific gravity.

QUARTZ

QUARTZ—*Rona.*

Sometimes the quartz has a beautiful green colour, owing to diffufed hornblende; and frequently the nearly-tranfparent quartz is variegated with beautiful fpots and ftripes of a fifkin-green colour: thus forming a beautiful foffil. It is alfo to be obferved of a red colour; and, being mixed with the common quartz, it is not unlike a granitel.

ON

ON PEAT.

CHAP. XXIV.

Obfervations on PEAT.

AS this fubftance is mentioned in all the Syftems of Mineralogy, and as it occurs in great quantity in the Iflands which I have juft defcribed, I do not think it neceffary to apologife for the publication of the following obfervations and experiments. I propofed, in a former work *, to continue my inveftigations with regard to this fubftance, and had begun a new feries of experiments, when the Highland Society, by offering a prize of 50 guineas for the beft account of Peat, induced me to wait the publication of thefe prize effays, which will, no

* Outline of the Mineralogy of the Shetland Iflands.

no doubt, contain many new obfervations and experiments. If, however, the experiments, communicated in thefe memoirs, be different from what I had begun, I will certainly continue the plan I had laid down.

This curious and ufeful fubftance has been long known as an article of fuel to the inhabitants of the North of Europe, and ufed as fuch, in thofe regions where no coal has been found, to defend the inhabitants from the rigors of a frozen climate. The learned Torfœus informs us, that its ufe was firft made known to the inhabitants of the Orkney and Shetland iflands, by one Einar, a Norwegian, who, from that circumftance, was named Torf Einar. It foon after this came into very general ufe, and is now the only fuel of many parts, not only of the iflands and Highlands of Scotland, but of other nations in the North.

In defcribing the general appearance of a peat moor, we may conceive an almoft entire flat of feveral miles extent, of a brown colour, here and there marked with tufts of heather, which have taken root, owing to the more complete decompofition of the furface peat; no tree or fhrub is to be feen; not a fpot of grafs to relieve the eye, in wandering over this dreary fcene. A nearer examination difcovers a wet fpungy fur-

face, paſſable only in the drieſt ſeaſons, or when all nature is locked in froſt. The ſurface is frequently covered with a ſlimy black-coloured ſubſtance, which is the peat earth, ſo mixed with water, as to render the moſs only paſſable by leaping from one tuft of heather to another. Sometimes, however, the ſurface of peat moſſes has a different aſpect, owing to the greater abundance of heath and other vegetables, as the ſchœni, ſcirpi, eriophora, &c. but this is principally the caſe with ſome kinds of what are called Muirlands, which contain but little peat, being nearly compoſed of the interwoven fibres of the roots of living vegetables.

Many different ſpecies of peat might be deſcribed, but ſuch an inveſtigation is not ſuited to my preſent purpoſe; I ſhall therefore content myſelf with mentioning the ſubſtance in a general way. Quick moſs (as it is called) is a ſubſtance of a more or leſs brown colour, forms a kneadable compound, and when good, cuts freely and clean with the ſpade; but when it reſiſts the ſpade, by a degree of elaſticity, it is found to be leſs compact when dried, and is of an inferior quality. The beſt kinds burn with a clear bright flame, leaving light coloured aſhes; but the more indifferent kinds, in burning, often emit a diſagreeable ſmell, and leave a heavy red-coloured kind of aſhes. In digging the peat we obſerve that, when firſt taken

from

from the pit, it almoft immediately changes its colour, and in time becomes more or lefs of a deep brown or black colour; and the peat matter becomes much altered, being incapable of forming a kneadable pafte with water. When dry and reduced to powder, as it is often by the action of the weather, it forms a blackifh-coloured powdery matter, capable of fupporting vegetation, when calcareous earth is added. Peat earth is very retentive of moifture, which circumftance affords us a fatisfactory explanation of the floating iflands, obferved in many places of Holland, as Frife, Breme, Groningue, Oldenburg, &c. Thefe are caufed by the peat earth or turf, retaining fo great a proportion of water as to float immenfe maffes of it, which are driven about upon the furface of lakes, or are floated upon the land itfelf. This is fo well known in Holland, that tracts of mofs, of great extent, are fecured by means of chains, &c.

Peat is found in various fituations, often in vallies or plains, where it forms very extenfive deep beds, from three to forty feet deep, as thofe in Aberdeenfhire; it alfo occurs upon the fides of mountains, but even there it is generally in a horizontal fituation. The tops of mountains, upwards of two thoufand feet high, in the Highlands of Scotland, are covered with peat of an excellent kind. In Germany, it is alfo found at

very great heights; thus the Blogſberg, a high mountain in Lower Saxony, and the Brohen, the higheſt mountain in the Hartz, are covered to their ſummit with peat. It is alſo found in ſituations nearly upon a level with the ſea; thus the great moſs of Cree in Galloway, lies cloſe upon the ſea, on a bed of clay, little higher than flood-mark at ſpring tides; Locker-moſs, hard by Dumfries, about ten miles in length, is only a few feet above high water mark; in the iſland of Lewis, one of the Hebrides, there is an extenſive plain, about thirty miles long, covered with peat moſs, having its ſurface very little elevated above that of the ſea. In other places, as in Holland, a kind of peat is obtained by dragging mud from the bottom of canals, and moulding it into the form of bricks; this ſpecies is alſo often taken up upon the flukes of anchors, on the coaſt of Holland, and is ſometimes caſt aſhore in ſtormy weather, which has led ſome ſpeculators to imagine that it is of marine origin. In the harbour of Oban in Argyleſhire, one part of the bottom appears to be formed of quick moſs, which affords no ſure anchorage. The depth of the ſea is there about twenty fathoms *.

Sometimes peat is to be obſerved alternating in thin ſtrata with ſand or clay: of this, I have obſerved inſtances in the Orkney

* Anderſon's Treatiſe upon Peat Moſs.

Orkney iſlands; and in the ſecond volume of the Journal des Mines, I find ſimilar appearances noticed in France.

It appears to be peculiar to cold climates, which is one of the innumerable inſtances of the wiſdom of nature in providing the inhabitants of a cold country, with a material ſo neceſſary for their comfort, and even their exiſtence. Dr Anderſon, in his Treatiſe upon Peat, remarks, that it is not confined to cold climates, as he had ſpecimens of real peat ſent from the iſland of Sumatra. It is not improbable that a ſubſtance reſembling peat in ſome of its properties, may be found in the warmeſt countries, when we reflect that decayed vegetable matters, in a certain ſtage of their decompoſition, have an appearance ſo like peat, that they want only compreſſion to form a ſimilar ſubſtance. On this account, it is not ſurpriſing, that ſomething of this kind ſhould occur in the warmer regions; but great maſſes of matter like our peat, can hardly exiſt in the Tropical regions. This obſervation is rendered more probable from the following remarks: In Scotland, it is obſerved, that the peat, at the bottom of a mountain, is more decompoſed than at its top, and the wood of moſſes is more freſh upon the higher part of a mountain than at its lower. It is alſo remarked, that the peat of the South of England is more decompoſed than that of the North of Scotland;

land ; and the peat of France has more of the coaly appearance, than that of England. In France alſo, Mr Arthur Young remarks *, that the peat is never found in the low lands, but under cover of vaſt ſize ; and it is only in the higher regions, where the climate is more temperate, that it is to be obſerved upon the ſurface. All theſe facts ſhow us, in a ſatisfactory manner, that as we advance towards the warmer climates, the vegetable matter is more and more decompoſed, until we arrive at the Tropical regions, where, in all animal and vegetable matters, putrefaction proceeds ſo rapidly, as to prevent the formation of any body of this ſubſtance.

It will not be foreign to my preſent purpoſe, to mention, in a curſory manner, the moſt remarkable undecompoſed vegetable matters, which have been obſerved in our peat moſſes, or bogs ; particularly as writers have endeavoured to draw concluſions, with regard to the time and mode of formation of peat, from the appearances which theſe bodies preſent.

1. Fir or Pine. This tree more frequently occurs, than any other ; it is found of various ſizes, ſome having been dug about one hundred feet long, perfectly ſtrait, with branches growing in

* Travels through France.

in a circular form; as is the cafe with the pine tribe. It is remarkable, that in fuch fituations the wood has often loft its latitudinal adhefion, which renders it foft; but that the longitudinal fibres are ftrong and tough, fo that they are fplit, and twifted, to form halters for cattle, as in Aberdeenfhire.

2. OAK. In all the low moffes, in Scotland, this tree is the principal one which is to be obferved, and is generally found wanting the bark, which fhews that the wood had been long dead before it had been enveloped in the mofs. In draining Hartfell level, in Yorkfhire, oak trees were found, not lefs than 100 feet long. They were black as ebony, in excellent prefervation, and fome of them fold, in the middle of the laft century for 15l. a tree. One of them, which is particularly defcribed, was about one hundred and twenty feet long, twelve in diameter, at one end, and fix at the other; and 20l. was offered for it. Beckman alfo informs us, that wood which has long lain under water becomes black, and looks as if charred; it however lofes none of its toughnefs or compactnefs; and many trees, dug up in Holland from the turf earth, are employed there for fhip-building.* Dr Anderfon remarks, that he never faw a piece of oak taken from a peat mofs,

* Beckman, 6 vol. New Tranfactions of the Royal Society of Gottingen.

mofs, which could be ufed in workmanfhip, like the ftakes which were lately taken from the Thames, and faid to have been placed there by Julius Cæfar; from this he concludes that mofs does not preferve wood fo long as water. This, however, is contradicted from the facts obferved at Hartfell level, and that mentioned by Beckman.

3. Birch. This tree alfo frequently occurs in our peat moffes, but its wood is not fo refinous as that of the fir, nor has it the hardnefs of the oak; on thefe accounts it is feldom found in a ftate of good prefervation; the bark is generally the moft entire, which may depend upon the great quantity of refin which it contains, which enables it to refift the all powerful hand of time.

The alder, yew, willow, afh, and feveral other trees, have been dug out of our moffes; but any detailed account of thefe would lead me to a great deal of unneceffary defcription: I may here mention, however, that, befides trunks and branches of trees, we alfo fometimes difcover their more delicate parts in a ftate of prefervation: thus, the leaves have been obferved well preferved. Seeds, which have a remarkable power in refifting the influence of the weather, have been found in peat moffes; thus we have inftances of fir cones and hazel nuts; the

the kernel of this laſt was deſtroyed, and the ſhell, which is very indeſtructible, was freſh.

Beſides trees and herbaceous plants, another tribe deſerve to be particularly noticed, which are the muſci. Theſe plants are fond of moiſture, and, with a ſufficiency of room to ſpread upon, and a cold climate, grow very faſt and luxuriantly. Of theſe the moſt remarkable is the ſphagnum paluſtre of Linnæus, which is found in great abundance in all peat diſtricts, particularly in thoſe places where the ſoft white peat abounds; this peat is found ſeveral feet deep, and is nothing but a collection of the ſphagnum, which we can obſerve more or leſs decompoſed as we go downwards; at laſt its texture diſappears, its colour changes, and it cannot be diſtinguiſhed from the common brown peat.

I have in my poſſeſſion ſpecimens of a ſubſtance, which was found in the peat moſſes of the Highlands; it anſwers to the Bergfet of the Germans, the Mineral Tallow of Mr Kirwan.

Deſcription. Colour, white; has nearly the reſemblance of tallow, feels greaſy, and ſtains paper as tallow does; flames with much ſmoke, leaving a pretty light coaly matter. It is brittle like tallow, but its ſpecific gravity is conſiderably leſs.

A ſubſtance ſimilar to this was found ſome years ago by peaſants on the coaſt of Finland, afterwards in one of the Swediſh lakes; and, more lately, Dr Babington informs us that it is found in great quantities in New Holland. Some have imagined that it is tallow which has been accidentally depoſited along with the peat, and, by long expoſure to the influence of the vegetable juices, may have been altered. This cannot be the caſe, as we are utterly unacquainted with any ſuch changes; and beſides, the circumſtance of its being found in great quantity in New Holland, leads us to ſuppoſe that it is not accidental. The editor of the Bibliotheque Britannique ſuppoſes that it is a ſubſtance ſimilar to the fatty matter into which the muſcular fibre is converted, when long expoſed in particular ſituations.

A great number of extraneous ſubſtances have alſo been found in peat moſſes, ſometimes at conſiderable depths; from their appearance, declaring, in certain characters, the great antiquity of ſuch moſſes. Many curious inſtances of this kind might be mentioned; one in particular deſerves to be noticed. In digging a moſs at Axholm, in Lincolnſhire, the body of a woman was found pretty freſh, her hair was unaltered, her nails were rounded, and her ſkin was tanned, ſoft and pliable; ſhe had antique ſandals upon her feet, which renders it probable

ble that ſhe was of the Roman æra. Another curious inſtance occurred in Shetland; in digging a peat moſs, the body of a man was found well preſerved, which, it was ſuppoſed, could not have been in the moſs leſs than eighty years. In the Iriſh moſſes the horns of the mooſe deer have been found; in our own, the head and horns of the urus occur. Dr Walker has in his poſſeſſion a drawing of the head and horns of a deer, found in a peat moſs, of a ſpecies now no longer found in Britain. Other ſubſtances occur in moſſes; thus, fragments of very ancient dreſs, and many inſtruments of human induſtry have, at different times, been diſcovered.

Analysis of the Peat of Glen-Cloy, Island of Arran.

Character.

It is of a blackiſh brown colour, pretty much intermixed with undecompoſed vegetable matter, which renders it rather looſe in its texture.

Solution in Water. *

1. I took one thoufand grains of powdered peat, boiled it repeatedly with diftilled water, until no more could be diffolved, then dried, weighed, and found eight hundred grains remaining.

The

* Lord Dundonald remarks,† that "the fulphuric acid, when concentrated, acts in a fimilar manner to that of alkaline fubftances, in the refolution or deftruction of animal and vegetable fubftances, difengaging from them certain gaffes, and forming therewith certain faponaceous and faline compounds. Thefe folutions or extracts are of a reddifh-brown colour, fimilar to that produced by the action of alkaline falts on oxygenated peat. On the principles already ftated, the vitriolic acid may be ufed beneficially to decompofe, and bring into action the infoluble matter accumulated in foils, by the combination of the phofphoric and foreline acids, with calcareous matter." The action of the fulphuric acid upon vegetable fubftances engaged my attention five years ago, and in a paper read to the Royal Medical Society of Edinburgh, I endeavoured to fhew (what has been fince done more fatisfactorily by Vauquelin and Fourcroy) that acetous acid is formed; that a portion of carbonaceous matter, deprived of hydrogen, remains in folution, and that carbon is feparated. It is certain that alkalies exert no fuch influence upon vegetable

† A Treatife of the connection of Agriculture with Chemiftry, 4to, by the Earl of Dundonald.

The folution had a deep brown colour, with a flightly bitter tafte; tinged litmus paper; and, by expofure to the air for fome time, part was precipitated in an infoluble ftate.

2. By paffing the oxygenated muriatic acid through this folution, a precipitation of a dark-brownifh matter immediately takes place, fimilar to what we obferve by paffing this acid through other vegetable infufions.

3. Cauftic

vegetable fubftances; in the prefent inftance, they only diffolve a portion of brown dehydrogenated matter, without caufing any alteration in the proportion of the conftituent parts. Their action upon animal fubftances, however, is more nearly allied: Vauquelin found, that ammonia was formed by the action of this acid; and I have reafon for fufpecting that a fimilar change is produced by the agency of potafh or foda upon the mufcular fibre. A feries of experiments, which my father was lately engaged in, at the defire of the honourable Board of Truftees, led me to make this obfervation. We found that the mufcular fibre of fifh, formed a brown-coloured folution, by treating it with the cauftic potafh or foda: during the folution, a fmall quantity of ammonia was formed, but in a far greater proportion, when tallow is added and the boiling continued. During this extrication of ammonia, a blackifh-coloured matter falls to the bottom, which is not acted upon by alkalies; in fhort, it appears to be the carbonaceous matter of the mufcular fibre. This change appears to be a nearly complete decompofition of the mufcular fibre, its hydrogen and azote forming the ammonia, whilft the carbonaceous matter is left behind, forming the infoluble matter. Vide Nicholfon's Journal.

3. Cauftic ammonia, or carbonat of potafh, did not caufe any precipitation in the fpace of twelve hours.

4. Pruffian alkali did not afford any traces of the combinations of iron, copper, or zinc.

5. Lime water formed a copious brown-coloured precipitate.

6. Muriat of barytes, nitrat of filver, fulphat of iron, fulphat of copper, caufed confiderable precipitations; but nitrat of ammonia, muriat of foda, muriat of ammonia, did not produce any change.

The folution, being evaporated, left a blackifh-brown coloured refiduum, which had no peculiar fmell. It prefents the following characters:—

a. Not foluble in fpirit of wine, except by a boiling heat.

b. Difficultly foluble in water, without the affiftance of heat.

c. Soluble

c. Soluble in cauftic foda, at the common temperature, or when heated.

d. Soluble in cauftic ammonia, in the fame manner.

7. A quantity of the refidue being put into a retort, connected with a pneumatic apparatus, a gradually-increafing heat was applied, when the following appearances were obferved. At firft, water paffed over, quite colourlefs; after fome time, it was tinged brown; and towards the end of the operation, when no more brown liquor came over, carbonic acid, and carbonated hydrogen, paffed in confiderable quantity. No oil or faline matter could be detected, and not the leaft traces of ammonia could be perceived. The carbonaceous refidue was of a blackifh-brown colour; infoluble either in hot or cold water, but eafily foluble in a weak folution of cauftic foda.

The eafe with which this carbonaceous matter is diffolved in weak folutions of alkali fhows, that it contains a confiderable portion of hydrogen; (at leaft this is the explanation given by modern chemiftry:) for I find it impoffible to diffolve any perceptible quantity of charcoal with fuch folutions.

8. The refidue, by burning, affords a grey-coloured afh; which I examined, in order to afcertain the nature of the faline

line matters. It did not afford ſulphat of potaſh or ſoda, phoſphat of lime, or phoſphat of iron; only *ſulphat of magneſia*, and *oxyd of iron.*

To the eight hundred grains, which I found inſoluble in water, I added a ſolution of cauſtic ſoda, which acquired a brown tinge at the common temperature; but, when heated, a very deep-brown coloured ſolution was formed. After repeated digeſtion with the alkali, I was able to diſſolve four hundred grains: the remainder was undecompoſed vegetable matter, which was quite inſoluble in the alkali I uſed.

I next added muriatic acid to this alkaline ſolution; the diſſolved matter was precipitated of a brown colour, and did not appear to be altered by its combination with the alkali: for it was ſtill ſoluble in cauſtic ſoda and ammonia, inſoluble in water by boiling, but ſoluble in ſpirit of wine. When burnt, a brown-coloured aſh is left, which afforded ſulphat of lime and oxyd of iron; but in no inſtance did I find phoſphat of iron, or phoſphat of lime.

Properties

Properties of the Acid contained in Peat.

In relating the characters of the aqueous folution, I obferved that it tinged litmus paper red. This fhows the prefence of an acid, which I found to poffefs the following characters :—

1. It is not cryftallizable, but may be obtained by evaporation, in the form of thin crufts.

2. Tafte, flightly acid.

3. Forms compounds with lime, barytes, and foda; which I have not particularly examined. The compound of lime and this acid is difficulty foluble in water; which diftinguifhes it, on the one hand, from the Gallic acid, as it forms a very foluble compound with lime; on the other, from the oxalic, which forms an infoluble falt with lime *.

 4. De-

* Lord Dundonald affirms, that peat contains the oxalic and phofphoric acids, which, according to his explanation, are of great ufe in feveral of the operations of nature: thus, when lime is added to peat, it is imagined that an oxalat of lime is formed; which, by the addition of fulphuric acid, is decompofed, and a gypfum formed;

4. Decompofes the acetite and nitrat of lead.

5. With fulphat of copper, a copious brown-coloured precipitate is formed, having a beautiful green fupernatant liquor.

6. With fulphat of iron, it forms a brown precipitate, and a nearly colourlefs fupernatant liquor.

7. Nitrat of copper changes the folution to a beautiful green, without caufing any precipitation. In this it alfo differs from the oxalic acid, which caufes a copious precipitation.

8. Muriat and nitrat of barytes are decompofed by it.

9. With a folution of fulphat of indigo, it forms a beautiful green colour: in this it alfo differs from the oxalic acid, which does not produce any change of colour.

This

formed; while the oxalic acid enters into new combinations, ufeful in promoting the growth of plants. We have already fhown, however, that this acid of peat is very different from the oxalic; but, allowing it to be the fame, it is contrary to well known chemical affinity, to fuppofe, that the fulphuric acid can decompofe the oxalat of lime. In the experiments I have made, none of the combinations of phofphoric acid appeared.

This acid appears to be the ſame with the ſuberique acid, lately diſcovered by Buillion La Grange, and which he imagines to be a compound of carbon, hydrogen and oxygen.

Diſtillation of Peat.

A quantity of this peat was carefully diſtilled, when a deep yellowiſh-brown coloured liquor was obtained: it had a ſtrong empyreumatic ſmell, and, by expoſure to the air, it acquired a conſiderable conſiſtence. I did not examine particularly this liquor: I only found that, by the addition of quicklime, much ammonia was ſeparated. Giroud, in the firſt volume of the Journal des Mines, mentions pretty fully the properties of this liquor. He finds that it is an ammoniacal ſoap; which, from the many experiments he made, he thinks, may become of conſiderable uſe: thus, the ammoniacal ſoap, being decompoſed by ſea ſalt, would form a cheap muriat of ammoniac, and the oily matter, by proper management, may anſwer for ſome purpoſes in the arts.

Carbonization of Peat.

The late improvements in agriculture have pointed out a method of converting much of the peat, which is ſo abundantly ſpread over the Highlands, into a good and productive ſoil: yet ſtill there is a great deal of it loſt, not only in theſe operations, but alſo from its being ſituated where the labours of the farmer would be employed with little advantage. From theſe circumſtances, it is certainly deſerving of attention, to endeavour to diſcover ſome means of employing this waſte vegetable matter; and thus to raiſe new ſources of induſtry in parts of the country where there are now only extenſive and dreary waſtes, without an inhabitant. As the want of common coal and charcoal, in moſt parts of the Highlands, appears to have been the cauſe why many promiſing mineral appearances have been abandoned; I think that it is not improbable that charcoal, from peat, may, if carefully prepared, be uſed with common charcoal, or even by itſelf, in the working of ores. This is not an opinion founded upon mere ſpeculation, for it has been actually put in practice in different parts of Europe: thus Baron Dietrich informs us that it is uſed in the Hartz for the ſmelting of iron ores. As the ſucceſsful proſecution of this practice would be of much conſequence to the Highlands of Scotland,

Scotland, I think it of importance to ftate fhortly the different methods that have been followed to obtain a good charcoal from peat.

Two methods have been followed in thefe trials: the one, by expofing the peat to a fmothering heat, as is practifed in the making of charcoal from wood; the other, by expofing it to heat in clofe veffels or furnaces, and thus fubjecting it to a kind of diftillation.

So long ago as 1631, Lamberville † feems to have ufed the firft procefs; but his attempts were not ultimately fuccefsful, as his charcoal was too friable; confequently, of no ufe in the forge, and other fimilar operations. In the Hartz, Dietrich obferved that they carbonifed the peat in large cylindrical iron veffels: but this was found to be too expenfive; befides, the volatile matter, feparated from the peat, was faid greatly to injure the veffels. At Villeroi, in France, peat was carbonifed by burning it in a furnace not unlike the common lime-kilns of this country: this method, like the other, was alfo found to be unprofitable. Thefe different methods, as Ribacourt † remarks, are very objectionable; as they do not allow the watery, oily, volatile and

† Journal des Mines, vol. 1.

and faline matters of the peat to feparate, without, at the fame time, confuming a portion of the carbonaceous matter, which caufes a great diminution of the peat: befides this inconvenience, the peat is always irregularly burnt; one portion being in the ftate of charcoal, the other, with a confiderable portion of the watery and other matters, not feparated.

The fecond procefs, which is the fubjecting the peat to a kind of diftillation, feems from all the trials which have been made to be the moft promifing. Pfeiffer, in a work entitled, Hiftoire de Charbon de terre et de la tourbe, &c. publifhed in 1777, defcribes a furnace, in which he diftilled peat, and obtained a folid charcoal. Thorin, in 1791, obtained a recompence from the French government for a method of carbonizing peat in an improved iron furnace, by which he obtained a firm and ufeful charcoal. This method, however, was foon found to be unprofitable, on account of the great wafte of the iron veffels by the fire, and the action of the volatile matters of the peat on them. More lately, Blavier ‡ has publifhed an account of a furnace, which is conftructed of ftone, and at little expence, and is faid to anfwer excellently for the carbonization of peat; and, befides, it has this advantage, that all the volatile,

‡ Journal des Mines, vol. 1.

volatile, oily, and alkaline, matters are eafily collected. I at one time intended to give drawings of this furnace, but I am confident that the importance of this fubject will lead the authors for the prize queftion, to make this the object of experimental enquiry. From this fhort account which I have given we have reafon to fuppofe, that by the adoption of a furnace fomewhat fimilar to that of Blavier, peat, at little expence, may be carbonized with advantage in the moft remote corner of the Highlands.

Before leaving this fubject, I will fhortly mention the various trials that have been made with charcoal of peat, with a view of determining the difference between it and that obtained from wood. Sage * found that the charcoal of peat gave a ftronger and longer continued heat than the charcoal of wood; and, further, that the charcoal of wood gives only a third of the heat of that of peat. Two furnaces of equal fize, and in every other refpect alike, were employed to melt a quantity of filver, when it was found that it required a greater quantity of charcoal of wood than that of peat to bring it into fufion. An experiment was alfo made in the great way at Paris to afcertain the utility of peat charcoal in the boiling of liquids,

* Journal de Phyfique, 1786.

quids, when it was here alfo found to have great advantages over that of wood. †

In metallurgic operations peat has been by fome confidered as very pernicious, while others find it not lefs ufeful than charcoal from wood. Dr Lind, in the Edinburgh Phyfical Effays, remarks, "that there exifts in peat an inflammable fubftance, "which produces upon metals the fame effect as fulphur, rendering them brittle. Another inconvenience which I have "had the misfortune to experience is this, that a ftrong heat "converts the charcoal of peat into a glaffy fubftance, which "collects along the fides of the furnace, obftructs it, ftops up "the paffage by which the melted metal fhould run, and hin- "ders it from collecting in the lower part of the furnace." This obfervation, which feems very unfavourable for the employment of the charcoal of peat in the fmelting of ores, probably deferves little credit; or if it be true, it only fhews us that it is neceffary that the nature of the peat fhould be known before it is employed, for, by its admixture with various extraneous matters, it may poffibly become pernicious. That it is innoxious and ufeful, Dietrich has proved; and even Lamberville, in 1626, affures us that it was fuccefsfully ufed in the

† Journal des Mines, vol. 1.

the working of iron. More lately, experiments were made at Paris, when even the temper of ſteel was not in the leaſt hurt by it. *

Soap from Peat.

I endeavoured in various ways to make a ſoap from peat, but always found that it gave a brown colour to the cloth. *See Nicholſon's Journal, Vol. III.*

Theory of the Formation of Peat.

The frequent occurrence of peat in many countries has naturally attracted the attention of philoſophers, who have endeavoured to diſcover the mode of its formation. One claſs of obſervers have contented themſelves by endeavouring to ſhow that it is of vegetable origin, and have only differed as to the probability of wood, or moſs alone, or jointly, having formed it; others again, having admitted its vegetable origin, differ only in the explanation of the means which nature uſes

* Journal des Mines, vol. x.

in the prefervation of the vegetable remains. Laftly, it has been conjectured, that it is a *live vegetable*, *fui generis* ; and an elegant poet having admitted its vegetable origin, has fuppofed fome changes it undergoes by elutriation, &c.

There can be no queftion of the vegetable origin of this fubftance : any other opinion is but vain and frivolous : and, it is alfo inconfiftent with fact, to affert, that either wood or mofs fingly are the only fubftances that form peat; for we know that in moft cafes they both contribute to its formation. In confidering the peculiar ftate of prefervation of the vegetable matter in peat, it is very generally believed that fallen wood, when it begins to putrify, produces an extract of the nature of tan, which preferves the mofs that grows up among the trees, and converts it into peat. This opinion is founded upon the known action of aftringent fubftances in preferving animal fubftances from decay; it will therefore be neceffary to examine this procefs, to difcover if it will help us to explain the phenomena of peat. It is but lately that we have had any probable explanation of the tanning procefs; and we are indebted to an excellent chemift, Seguin, for fome interefting experiments and obfervations upon this fubject. * He informs us,

* Journal of the Polytechnic School of France.

us, that oak bark, &c. contains two fubftances, the tanning principle, which has a great affinity for gluten, and the gallic acid, which has a powerful attraction for oxygen. When a folution of bark is applied to fkins, he fuppofes that the gallic acid abftracts oxygen from the mufcular fibre and reduces it to the ftate of gluten, when it immediately combines with the tanning principle, forming a compound, which is the caufe of the indeftructibility of leather. We have already fhewn that peat does not contain the gallic acid; but, allowing that it does, it is impoffible to conceive fuch an action to take place with regard to vegetable matters, particularly in peat, which I have found from experiment to contain no tanning principle. It will therefore be neceffary to inveftigate the influence of vegetable acids, &c. upon vegetable matters, before any probable opinion of this kind can be formed.

The fingularity of the appearance which peat prefents, has led Dr Anderfon to conclude, that it is a *live vegetable*, *fui generis*. This he imagines to be very fatisfactorily proved, from the fuppofed impoffibility of decaying vegetables poffeffing properties fimilar to peat. He remarks, " That in vegetables, " which have once fallen into a ftate of putrefcency, their in- " flammability decreafes in proportion as that putrefcency " augments; and that their chemical qualities fuffer an alter-

 tion

" tion proportioned to the ſame circumſtance. But by the " hypotheſis of every perſon who ſuppoſes that ſphagnum is " the original conſtituent matter of moſs, it is always under- " ſtood that the foggy peat, by their hypotheſis, is the ſphag- " num ſtill ſo little decayed, as not yet to have become per- " fect moſs; and, that in proceſs of time, it gradually be- " comes more and more perfect moſs, as it gradually becomes " more thoroughly putrid, till at laſt, it loſes even the appear- " ance of ſphagnum, and becomes hard, and perfect peat; " that is to ſay, in other words, as it becomes more putrid, it " becomes more inflammable, which is directly the reverſe of " the well known progreſs of nature in every other caſe." It is upon this and ſome ſimilar arguments, that the Doctor rejects the opinion of moſs being a collection of decaying vegetable matters. But to theſe we may ſhortly anſwer, that decaying vegetables only loſe their power of burning, with the deſtruction of their carbonaceous matter; but this we know requires a very long ſeries of years, and when the vegetable matters are in a moiſt ſituation, as is the caſe with peat, ſuch a decompoſition may be prevented for hundreds of years.

The laſt theoretical opinion with regard to peat, which I ſhall mention, is contained in a note of Dr Darwin's beautiful poem, the Botanic Garden. He there gives us a truly ſtrange account

account of the changes which peat mofs undergoes by elutriation, fermentation, and the confequent heat. As this is little elfe than a *dream*, it might be paffed over; but it is detailed in the form of matter of fact, and therefore requires to be noticed. He remarks, " That moraffes, in great length of time, undergo a variety of changes; firft by elutriation, and afterwards by fermentation, and the confequent heat. By water perpetually oozing through them, the moft foluble parts are wafhed away, as the effential falts; thefe, together with the falts from animal recrements, are carried down the rivers into the fea, where all of them feem to decompofe each other, except the marine falt. Hence the afhes of peat contain no alkali; and are not ufed in the countries where peat is ufed as the fuel of the lower orders, for the purpofe of wafhing linen. The fecond thing which is always feen oozing from moraffes, is iron in folution, which produces chalybeate fprings, from whence depofitions of ochre and variety of iron ores. The third elutriation feems to confift of vegetable acid, which, by means unknown, is converted into all the other acids. 1ft, Into marine and nitrous acids; 2d, into vitriolic acid, which is found in fome moraffes fo plentifully, as to preferve the bodies of animals from putrefaction, which have been buried in them; and this acid, carried away by rains and dews, and meeting with calcareous earth, produces gypfum or alabafter,

with

with clay it produces alum, and, deprived of its vital air, produces ſulphur. 3d, Fluor acid, which being waſhed away, and meeting with calcareous earth, produces fluor or cubic ſpar. 4th, The ſiliceous acid, which ſeems to have been diſſeminated in great quantity, either by ſolution in water, or by ſolution in air, and appears to have produced the ſand in the ſea, uniting with calcareous earth previouſly diſſolved in that element, from which have been afterwards formed ſome of the gritſtone rocks, by means of a ſiliceous or calcareous cement. By its union with calcareous earth in the moraſs, other ſtrata of ſiliceous ſand have been produced; and by the mixture of this earth with clay and lime aroſe the beds of marl." After this follow ſome whimſical notions about the formation of coal, which are connected with ſome ſuppoſed changes produced by fermentation and heat. We ſhall now, in as few words as poſſible, examine the truth of the ſuppoſed change by elutriation, which is all that intereſts us at preſent. As to the firſt poſition, that the ſalts are carried to the ſea and decompoſe each other, we have no manner of probability, far leſs proof. The third ſtage of elutriation, where a vegetable acid makes its appearance, ſhould have been confirmed by experiment; its ſuppoſed converſion into marine and nitrous acids is perfectly chimerical. I have not found ſulphuric acid in peat, nor does Dr Darwin inform us that he had detected

it;

it; therefore any reaſoning founded on its action muſt be ideal. * The exiſtence of the fluor acid in moraſſes, and the ſpeculations about the ſiliceous acid, are all conjectures as odd and improbable as could be contrived.

Having now mentioned the principal opinions with regard to the formation of peat; and having ſtated ſuch objections as occurred to me; I will now endeavour to aſcertain, upon chemical principles, the peculiar ſtate of the vegetable matter when in the form of peat. In viewing the various phenomena of decaying vegetables, two diſtinct ſtages may be obſerved—

* "The common vitriolic acid, I believe, has never been found in nature, free from all combination, though it may unite with ſome bodies beyond the point of ſaturation. It is true, Mr Baltaſſari ſays, he found ſome dry concentrated vitriolic acid adhering to ſelenite, in a grotto in Monte Zaccolina, near Sienna; but this has been fully diſproved by the ſubſequent obſervations of Mr Murray, in the 7th volume of the Memoirs of Stockholm, and of Mr Dolomieu, in his Notes upon Bergmann de Prod. Volcan. page 88." *Kirwan's Mineralogy, Vol. II. p.* 2.

More lately, however, in the eighth volume of the Bibliotheque Britannique, we are informed, that, upon examining a water from Savoy, it was found to contain a conſiderable quantity of uncombined ſulphuric acid.

ferved—the acetous and putrefactive fermentations. Thefe proceffes are much modified by circumftances; depending upon the degree of heat, moifture, the prefence of air, and the greater or longer continuance of the action of thefe agents. The putrefactive fermentation is the one which here claims our chief notice; for, attention to the appearances it prefents will enable us to judge better of the ftate of vegetable matter in peat.

In the putrefactive procefs, if the heat be confiderable, the deftruction of the vegetable matter is foon accomplifhed: the whole is diffipated in the form of carbonic acid, carbonated hydrogen, and fometimes ammonia; a fmall portion of charcoal and afhes being left behind *. A more moderate degree of

* It is plain, that, in general, wherever carbonic acid and carbonated hydrogen gaffes are formed, both earthy and faline matters will be left behind; for carbon, which enters into the compofition of thefe gaffes, contains neither earthy nor faline matters. This being admitted, we can account for the prefence of faline matters in plants, without any great ftretch of hypothefis. It has been difcovered by Lampadius, profeffor of chemiftry at Friburg, that charcoal decompofes water at the common temperature; and as all foils contain carbonaceous matter, it is plain, that, during the formation of thefe gaffes by the action of the fun's rays, a quantity of faline matter will be left in the foil for the ufe of vegetables.

of heat, with moiſture, allows the matters to decompoſe more ſlowly, and to preſent the vegetable matter in ſeveral other intermediate ſtages, ſuch as we obſerve with regard to peat when more or leſs decompoſed. A very great proportion of moiſture has a powerful influence in retarding this proceſs: thus, the trees, which are found at the bottom of moſſes, are freſher than thoſe at the top, owing to the bottom containing a greater quantity of water; and the ſtakes, lately taken out of the Thames, are another remarkable inſtance of this.

From theſe circumſtances, it is plain, that peat is a vegetable ſubſtance, which has undergone in part, and is ſtill undergoing, the changes which have been juſt mentioned; and many facts lead me to conclude, that the common peat, or quick moſs, is the vegetable matter, deprived of a conſiderable portion of its hydrogen. Not only the circumſtances attending the ſituation and appearance of peat, but alſo other facts, render this opinion probable.

1. Sulphuric acid being added ſlowly to oils, and triturated, they gradually become brown, when the oil is rendered ſoluble in water and ſpirit of wine; but, if the acid be added in too great quantity, a black inſoluble matter is formed.

 2. If

2. If oleum animale be expofed to the action of oxygenous gafs, water is formed, and carbon precipitated.

In this laft experiment, we perceive, that the feparation of hydrogen caufes the precipitation of carbon: and, in the experiment with the fulphuric acid, we obferve, that, in proportion as the hydrogen is diffipated, the carbonaceous bafis becomes more or lefs foluble in water; and when the whole of the hydrogen difappears, a true carbon is left behind. In the fame manner, with regard to peat, the woody, or other vegetable matters, are flowly deprived of a portion of their hydrogen, become brown, and fomewhat foluble in water and fpirit of wine; thus forming a kind of bituminous matter *. By a further decompofition, more hydrogen is feparated, when the vegetable matter becomes infoluble in water, but ftill foluble in alkali; laftly, nearly the whole of the hydrogen is feparated, when a black fubftance is left, what is called Peat Earth. This laft, by expofure to the air, combines with a portion of oxygen, forming fuberique acid; and appears to be what Lord Dundonald calls Oxygenated Peat.

If

* Vide Mr Hatchett's excellent paper on Bituminous Subftances, inferted in the 4th volume of the Linnæan Tranfactions.

If this explanation be thought to have probability in its favour, we may explain ſome other facts in a pretty ſatisfactory manner. Thus the great Captain Cook remarks, that the coaſt of Tierra del Fuego is covered with peat-moſs, and the water which runs from it has a brown turbid appearance. At one time, he was obliged to water upon this dreary ſpot, and could obtain no other water but that from the peat moſs, which made him very ſuſpicious of its good qualities, ſo that at firſt it was but ſparingly uſed. Having ſoon got into the warmer regions of the Pacific Ocean, he found that this water depoſited a ſmall ſediment, became pellucid, and was the moſt wholeſome and freeſt from putrefaction of any he had on board. It is probable that the infuſion of peat acted, in this caſe, in a ſimilar manner with charcoal, (from which it differs but little,) by abſtracting the putreſcent matter. Another curious fact is mentioned by Dr. Plott—that intermittent fevers never occur in the neighbourhood of peat-moſſes. This appears to be owing either to the ſlower decompoſition of the organiſed matter in peat-moſſes than in fens, by which a ſmaller portion of noxious gaſs is formed; or to the abſorption of theſe gaſſes by the peat matter approaching to the ſtate of charcoal. This laſt explanation is rendered the more probable from a well-known fact, that in church-yards, where a great number of dead bodies are buried, no bad ſmell is to be perceived; evi-

dently owing to the abforption of the noxious gaffes, by the carbonaceous matter of the foil.

Improvement of Moss Land.

The method of improving peat mofs, by means of calcareous earth, is certainly one of the moft ufeful difcoveries of the prefent day, and will, no doubt, form an important era in the annals of agriculture. Not long fince, peat lands were only confidered as ufeful on account of the fuel which they afforded. The cafe is now widely altered: the mofs grounds are eagerly fought after: and, in the weft of Scotland, this method of improvement is carried on with great fpirit, and is repaying the judicious manager very amply. To give a detailed account of the methods which are followed, (and that is the only one that can properly be given,) would require a volume; and, after all, would be little more than a repetition of what is already known. I fhall therefore content myfelf with endeavouring to apply the preceding experiments, to explain the mode of action of the calcareous earth.

We have already obferved that peat contains the fuberique acid, or one nearly allied to it, which appears to be formed in greater quantity the longer the peat is expofed to the action of the

the air; thus affifting in retarding the decompofition of the peat, of courfe preventing its being ufeful in vegetation. Marle, fhells and limeftone are ufeful, in a triple capacity: in the firft place, by removing the acid, the vegetable matter is allowed to decompofe more rapidly; fecondly, the combination of this acid with the lime, forms a compound, which may affift in vegetation; and, laftly, this acid having a ftronger attraction for lime than the carbonic, will difengage it in confiderable quantity, when it will affift vegetation.

I fhall conclude, with remarking, that there is a confiderable prejudice in favour of quicklime: if the explanation now given have any plaufibility, it is plain that carbonat will anfwer as well, if not better, in the improvement of mofs lands.

FROM

FROM BERNERA TO THE FRITH OF FORTH.

C H A P. XXV.

Journey from BERNERA, *by Fort-Auguſtus, Garvimore, Dalwhyn-nie, Dalnacardoch, Blair in Athol, Dunkeld, and Perth, to the Frith of* FORTH.

HAVING viſited all the iſlands that lie immediately along the weſt coaſt of Scotland, from the Craig of Ailſa to the iſland of Skye; we agreed to defer, till another ſeaſon, our expedition to the chain of iſlands that lie farther to the weſtward. We therefore left Armidale, in the iſland of Skye, and ſailed up the ſound to Elean-reach, which is ſituated upon the main-land of Scotland. Here we landed, after a pleaſant paſſage of three hours. The ſcenery, upon both ſides of the ſound, was grand, and particularly about Loch-Houron. Though the mountains are peculiarly rugged and ſterile, yet this rugged-

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nefs was foftened in the diftance; and the airy tints of their fummits, with the deep fhadows on their bafe, marking ftrongly their vallies and furrowed fides, formed a beautiful mountain fcene. As we paffed the mouth of Loch-Houron, the day was ferene; and the placid waters beautifully reflected the mountain fkreens, which fucceffively burft forth, and retired as we failed along. The houfe of Mr Macleod is a fheltered retreat, almoft hid among trees: it lies on the fea-fhore, on the fide of a grand amphitheatre of rocks, which opens to the found of Skye. As our ftay here was very fhort, I can fay little with regard to its mineralogy; yet, from what I faw, I have little doubt that, upon attentive examination, many interefting appearances might be difcovered. The rocks are entirely of primitive formation, and are compofed of micaceous fhiftus, gneifs and hornblende-rock, and are traverfed by great veins of granite. In feveral places, I obferved great maffes of lapis ollaris, which contained beautiful fpecimens of green actynolite, and green hornblende. We remained all night at this place, and in the morning fet out on our journey homewards. We walked along the fhore for about 2 miles to Bernera, where there are the remains of barracks that were built in this fequeftered fpot after the troubles in 1745. The rocks in this direction are ftill of the fame nature with thofe at Elean-reach, but principally of gneifs. From this we entered into Glen-elg;

which

which is an extenſive valley bounded on both ſides by great mountains. The lower part is cultivated, and vegetation is even obſerved covering the tops of the hills. The prevailing rock is micaceous ſhiſtus, but gneiſs is ſometimes to be obſerved in the higher parts; and both kinds of ſtrata are traverſed by granite veins. In our walk towards the upper part of the glen, I picked up ſeveral ſpecimens of tremolit, which adhered to maſſes of quartz, and ſeemed to be derived from the ſtrata or veins in the neighbouring mountains. Having reached nearly to the upper part of this glen, we aſcended, by a broken military road, to the top of a hill, which ſeems to be principally compoſed of ſienite. From this elevated point, we had a grand view of mountain ſcenery; vallies beautifully retiring, in miſty colours, among ſkreens of mountains, lightened with catching gleams: below us, appeared a pretty extenſive loch, apparently ſurrounded by lofty mountains. We now deſcended to the ſide of the loch, by many windings down a very rugged and ſteep road, when we obſerved that the loch communicated with the ſea, and its ſides were adorned with gentlemen's ſeats. Although the ſcene was ſtill beautiful, yet our ideas altered ſtrangely, when, inſtead of the calm and cultivated retreat on the banks of an inland lake, we found an oozy bank, covered with ſlime and ſea-weed, left by the retiring tide. The ſame ſienite rock continues to the ſide of the loch;

and

and from this to Ratachan Inn, which is ſituated at the upper part of the loch, the country is low, preſenting ſtrata of micaceous ſhiſtus.

As we were obliged to remain here the reſt of the day, we examined ſlightly the hills in the vicinity. They riſe to a a great height, are bare and rugged toward their ſummits, and, ſo far as my examination went, appeared to be compoſed of micaceous ſhiſtus, which ſometimes paſſes into gneiſs, and is traverſed by veins of granite.

We left the inn next morning before ſun-riſe, as we had to perform a long and dreary journey of nearly forty miles before the evening. Immediately after leaving the inn, we entered, by a narrow, abrupt paſs, into Glen-Sheill. Tremendous mountains roſe on each ſide, but, farther diſtant, all was dark and indiſtinct: it was but twilight; the obſcurity thus thrown over the ſcene was peculiarly impreſſive. Before us, towards the head of the glen, the clouds were cleared away as the day advanced, and the opening, the modeſt, mellow tints of the morning cheared us with the proſpect of a charming day for a journey through a country ſo dreary and wild. We were ſoon grievouſly diſappointed: the clouds were ſeen rapidly covering the mountains; the ravines, ſituated near the ſum-

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mits, appeared white, from the water rufhing over their rugged bottom; and foon the whole glen was obfcured, and the rain poured down with great violence. We continued our difagreeable journey, which had but little diverfity: only, now and then, a partial difperfion of the clouds allowed us to obferve many grand, peaked mountains, rifing to a tremendous height, far beyond the boundaries of the glen. At length, having reached far up the glen, we came to a narrow pafs, where the waters were collected from the neighbouring mountains. They were precipitated over rude fragments of the rocks; and, fwollen and pent up in a narrow channel, rufhed impetuoufly forth until they gained the level bottom of the glen, where the river flowed "calm, fluggifh, filent." Such fcenes are the greateft ornament of the Scottifh glens—where the ftream, collected from the rude mountains, glides thro' the moffy wilds, and defcends, by fucceffive falls, thro' the rocks, fhadowed by the overhanging woods, till gathering ftrength, "it boils, and wheels, and foams, and thunders thro." Indeed, in the courfe of this glen, we faw all the various beauties which a river difplays in a wild and mountainous country. The tumultuous noife of the waters was reverberated from the neighbouring mountains, and continued to be heard long after we had loft fight of them. The road was now nearly impaffable, torrents croffing it every few yards; which, in fome places, were fo rapid

and

and deep, as to endanger our lives in croffing them: our guide having ftumbled, with great difficulty faved himfelf. Having forded thefe torrents, we at length advanced into a more open part of the glen, where the road was better: here the ftorm began to abate; the clouds gradually rofe; and in a few hours the fun again beamed upon us. When we looked back to the mountainous fcene of Glen-Sheill, ftill obfcured by dark clouds, it formed a ftriking contraft with the fcene before us.

We now travelled, by a broken and winding road, to the fide of a loch called Clouny, which is of confiderable extent, and bounded on both fides by lofty mountains. On their lower parts, thefe mountains are fkirted by natural wood. We walked along the fide of this loch, to its farther extremity, which brought us nearly to the entrance of Glen-Morifon. This glen is confiderably different, in appearance, from Glen-Sheill: the hills which bound it are lower, and have much of the round-backed fhape. We defcended into this glen, and walked feveral miles, when we reached a dirty black houfe, called Unach Inn.

The country through which we had paffed in coming from Ratachan inn, will afford much inftruction to future travellers; but as my journey was rapid and attended with every

inconvenience, I can give but little information as to its peculiar nature. The mountains of Glenſheill appear to be compoſed of micaceous ſhiſtus, which is ſometimes alternated with hornblende ſlate, and veins of granite appear traverſing theſe ſtrata in various places. At Loch Clouny, however, the micaceous ſhiſtus diſappears, when great hills of red granite are to be obſerved; and this rock ſeems to bound both ſides of the loch, as is well marked, not only by the red colour of the debris along its banks, but alſo by the appearance of the broad flat faces, ſimilar to what we obſerve in the great granite glen Roſa in the iſland of Arran. This granite continues for about a mile, when the micaceous ſhiſtus again makes its appearance; and near the junction of the granite and micaceous ſtrata, great veins of granite are to be obſerved traverſing the micaceous ſhiſtus, and ſeveral of the veins ſeem to iſſue from the granite itſelf. The greater part of theſe granite veins, however, have a different appearance from that of the great body of ſtratified granite, its conſtituent parts being of a great ſize. The micaceous ſhiſtus continues to Unach inn, but it is in ſeveral places alternated with hornblende-rock, and traverſed by granite veins.

As the appearance of the granite veins ſhooting from the granitical ſtrata into the micaceous ſhiſtus, &c. has been conſidered

conſidered by the late Dr Hutton as a proof of the poſterior origin of granite to the ſtrata which cover it; I think it neceſſary now to conſider the plauſibility of an opinion ſo contrary to that of the beſt informed geologiſts.

Dr Hutton maintains, " that all the ſolid ſtrata of the earth have been conſolidated by means of ſubterranean heat; ſoftening the hard materials of theſe bodies; and that in many places theſe conſolidated ſtrata have been invaded by huge maſſes of fluid matter ſimilar to lava, but for the moſt part perfectly diſtinguiſhable from it †." Granite he conſiders as a body which has been transfuſed in a fluid ſtate from the ſubterranean regions, and made to break and invade the ſtrata in the manner of baſalt. His evidence for this opinion is as follows: He obſerved in the bed of the river Tilt, near to Blair in Athol, that the granite and ſhiſtus were much intermixed at their junction; and in the ſhire of Galloway and the iſland of Arran, veins of granite ſeemed to iſſue from the ſtrata of granite and traverſe the ſhiſtus; from this he concluded, as all veins are of a poſterior origin to the ſtrata which they traverſe, that the veins of granite which traverſe the ſhiſtus, being continuous with the granite, make the whole after formation

† Philoſophical Tranſactions of the Royal Society of Edinburgh, Vol. III.

mation to the ſhiſtus. Many objections occur to this hypotheſis, and I ſhall now mention a few of them.

1*ſt*, If granite had flowed from below, how does it happen that after it had burſt through the ſtrata of micaceous ſhiſtus, &c. it did not overflow the neighbouring country? If this hypotheſis were true, Mont Blanc could never have exiſted.

2*d*, If the granite had been forced up with the violence which Dr Hutton ſuppoſes, we ſhould expect that the ſtrata of micaceous ſhiſtus, or other ſtrata that cover granite, ſhould be invariably diſturbed and broken in every direction, but more particularly at their junction. This is by no means the caſe; Sauſſure, Charpentier, and others, have examined vaſt tracts of granite country without obſerving ſuch appearances; and in Scotland I have examined great tracts of granite, but the appearances deſcribed by Dr Hutton occurred rarely.

3*d*, If all kinds of granite have been ejected from below, and if all veins of granite communicate with a central maſs of granite, how ſhall we explain the appearance of granite veins in countries where no ſtrata of granite have been obſerved? nay, where theſe veins have been traced from their beginning to their

their termination in the ſhiſtus, a ſufficient proof that they are not connected with any granite underneath?

4th, The general obſervation that the granite which runs in veins has a character different from that found in ſtrata, intimates ſtrongly that it has been found at a different period from the granite in ſtrata.

Theſe objections bear much againſt Dr Hutton's opinion, and may probably appear, in a conſiderable degree, to diſprove it. I ſhall not ſtop here, however, but ſhall now mention a fact, which to me ſeems to remove in a conſiderable degree the doubts with reſpect to the connection of the granite with the other ſtrata. The obſervations of Werner, Charpentier, Sauſſure, Reuſs, and other geologiſts of the higheſt character, have demonſtrated that granite, when it is covered by ſtrata of gneiſs, gradually acquires a ſhiſtoſe fracture, and at length is not to be diſtinguiſhed from it; the gneiſs, when covered by micaceous ſhiſtus, gradually paſſes into it by the loſs of its felſpar; and laſtly, when ardeſia, or primitive argillaceous ſhiſtus covers the micaceous ſhiſtus, a diſtinct gradation is to be obſerved by the diſappearance of the quartz, and the encreaſe of the argillaceous ingredient. Here then we have a demonſtration that theſe different ſtrata have been formed in

the

the ſame manner, and nearly at the ſame time; therefore any ſpeculations which refer to one of theſe kinds of ſtrata are equally applicable to the others; conſequently the hypotheſis of Dr Hutton is to be conſidered as unſatisfactory. The tranſition of theſe ſtrata into each other is not an appearance confined to one country; it has attracted the notice of geologiſts in all parts of the globe, and has been univerſally conſidered as a proof of the identity of the formation of theſe different ſtrata. The appearance of the veins of granite ſhooting from the ſtrata of granite into the ſhiſtus, may be explained in the ſame manner as common veins. Granite ſtrata are frequently traverſed by veins of granite, and theſe veins, although in general of a different grain from the rock through which they run, yet, in ſome inſtances, it is with great difficulty that we can diſtinguiſh them from the ſtratified rock. Now, as it is nearly demonſtrated that granite, gneiſs, micaceous ſhiſtus, and ardeſia, are of the ſame formation, it is not at all improbable that rents would as readily extend through the gneiſs and granite, as through the gneiſs and micaceous ſhiſtus; and that theſe rents would be afterwards filled up with granite ſimilar to that of the ſtrata, and thus form the appearance of the granite invading the ſhiſtus. The maſſes of granite encloſed in the ſhiſtus, and of ſhiſtus encloſed in the granite which are obſerved

where

where the granite and fhiftus meet together have been explained in another part of the work.

I cannot leave this fubject without mentioning that Dr Hutton afferts that granite is not ftratified, and confequently that this is a proof that it has been formed at a different time and in a different manner from the other ftrata which cover it; and he applies the fame reafoning to porphyry and bafalt, which he fays are not ftratified. It is now well proved, however, as I have mentioned in a former part of the work, that granite is difpofed in ftrata; and no one, I think, can doubt that porphyry and bafalt occur in ftrata in many parts of the world. Indeed thefe are very common appearances. The ingenious Sir James Hall, a fupporter of the Huttonian theory, remarks, that the mineral kingdom is divided into ftratified and unftratified bodies, the latter comprehending granite, porphyry, and bafalt *; but he underftands by ftratification, the flaty fracture of the ftone. He is here in an error, as we have great mountains of fhiftofe porphyry †;

* Edinburgh Philofophical Tranfactions, Vol. III.

† Although porphyry, in general, does prefent a uniform and compact ftructure, yet, when it is quarried, it rifes in large flat maffes, or when broke by a hammer, it yields more eafily in one direction than another; confequently it has the fhiftofe ftructure, but in a lefs perfect degree than micaceous fhiftus or ardefia.

and ſhiſtoſe baſalt || and granite, have been frequently obſerved.

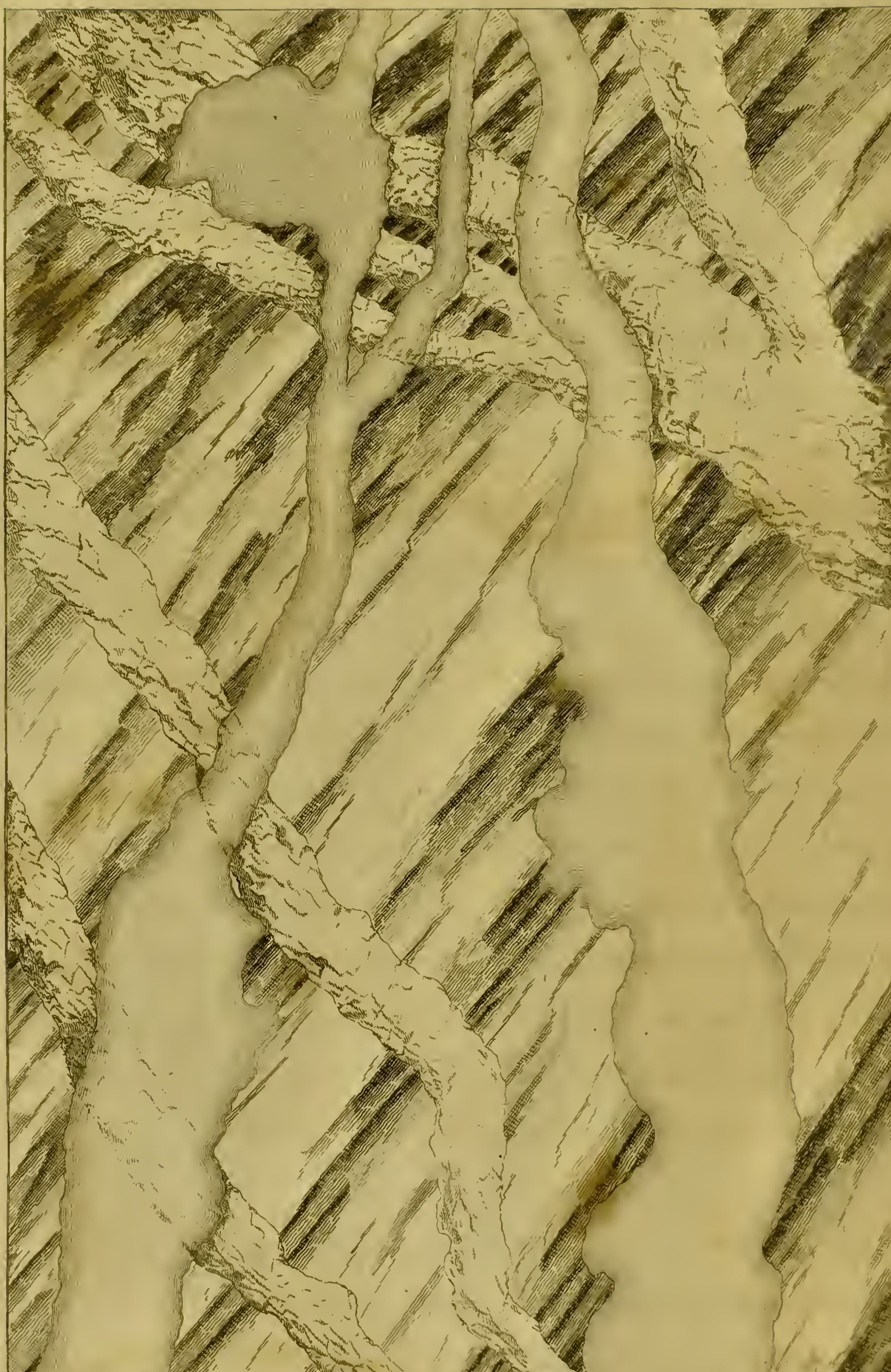
Having reſted a little at Unach inn, we ſet out for Fort Auguſtus. The road was firſt up a ſteep hill, which is compoſed of micaceous ſhiſtus alternating with hornblende ſlate, and traverſed by granite veins. Having reached the top of the hill, we had a good view of Glen-Morriſon nearly to its further extremity, bounded on both ſides by grey hills, all apparently of a ſimilar compoſition with that on which we were ſtanding. We now walked pleaſantly along for ſeveral miles through a muirland, when we came to a hill upon one ſide of the

|| Reuſs obſerved, near to Teplitz, the top of a hill compoſed of baſaltic columns; under theſe he obſerved baſalt in very thin tables; and, lower down, the baſalt was obſerved paſſing completely into ſhiſtoſe porphyry. He alſo obſerved the ſhiſtoſe baſalt forming a vein, which traverſes common ſandſtone. Reuſs Mineralogiſche Geographie von Boehmen.—And Charpentier has obſerved granite decidedly ſhiſtoſe, and even where it had not externally the ſhiſtoſe texture, he found that it always broke in a certain direction, and when raiſed from the quarries, that it riſes in great flat blocks; but it is only in a particular direction that theſe maſſes could be raiſed. At Aberdeen, where there are immenſe granite quarries, the workmen have the daily experience that the granite riſes more eaſily in one direction than another, and alſo that in dreſſing it, their work is much haſtened by breaking the ſtone in a particular direction.

the valley, in which Fort Auguftus is fituated. Below appeared the Fort, which has more the appearance of a manfion-houfe than a place of ftrength, but is charmingly fituated upon the extremity of Loch Nefs; and at a diftance the great mountain of Ben-Nevis, the Mont Blanc of Scotland, was feen half wrapped in the clouds, which almoft perpetually encircle its lofty fummit. We now defcended by a winding road over ftrata of micaceous fhiftus, traverfed by granite veins, and in a little time reached a comfortable inn, which was the more agreeable after our long walk from Ratachan inn.

Having refted all night, we fet out in the morning for Garvimore, preferring it to the route by Fort-William. The road continues for a confiderable way to be very fteep. It leads over a hill, which is compofed of micaceous fhiftus, and is probably traverfed by granite veins, as I remarked upon places of the road great maffes of granite, that feem to have come from the neighbouring rocks. Having reached the fummit, we walked for feveral miles among heathy mountains, compofed principally of micaceous fhiftus, until we came to the foot of the mountain called Coriariach. We afcended it by a long, winding, tedious road of fix miles: it was extremely dreary and defolate; not a human being, not a bird was to be feen; and the long bleached poles that are erected along the road to

direct the traveller during the snow had a singular appearance. From the summit, we had a very magnificent spectacle of the tremendous peaked mountains extending along the west coast of Scotland. This hill, and the neighbouring one, as far as I could judge, are entirely of primitive rock, and appear to be principally formed of different species of micaceous shistus. I observed upon the road masses of quartz of a nearly black colour, thus approaching in external character to the obsidian. Reuss, in his mineralogical history of Bohemia, informs us, that he found specimens of obsidian passing into quartz, and that he has in his possession a crystal, where the one half is obsidian, and the other quartz. These appearances observed by Reuss, as also the black quartz of Coriaraich, are probably no real gradation to obsidian, but merely quartz coloured deeply with iron or inflammable matter; the trial of its fusibility will help to determine this point. I also observed upon the top of the mountain fragments of compact felspar, which must either form veins traversing the strata, or alternate in the manner of strata; the latter supposition is the more probable. We now descended by a very zigzag and steep road, to the bottom of the mountain, when we entered into Glen-Drummond, through which runs the river Spey, having its origin in the neighbouring mountains. Many small heather-covered hills were scattered below the lofty precipices; and, upon examination



GRANITE VEINS TRAVERSING MICACEOUS SHISTUS GLEN DRUMMOND BADENOCH

ination, appeared to be formed of the debris wafhed from the mountains. We now continued our dreary journey through this defolate country. As we approached to Garvimore the ftrata of micaceous fhiftus were fucceeded by confiderable hills of granite, but thefe continue only for a little way, when micaceous fhiftus is again the prevailing rock, and continues to the inn at Garvimore. The micaceous fhiftus, however, is much traverfed by veins of granite, which are from an inch to 12 feet wide. At the bridge which croffes the Spey, at a little diftance from the inn, we obferved in the bottom of the river a fine difplay of the granite veins, a fmall part of which is reprefented in the plate. Thefe veins traverfe the ftrata in various directions, and fometimes they appear to inclofe maffes of the micaceous fhiftus, as is well expreffed in the engraving. In feveral of the blocks of granite that lie fcattered about, I obferved maffes of micaceous fhiftus inclofed, and alfo in the maffes of the micaceous fhiftus, pieces of granite were included. The hills in the neighbourhood of this houfe are of confiderable height, and are generally compofed of micaceous fhiftus, traverfed with granite veins.

We left Garvimore by fun-rife; the morning was cool and pleafant, fo that our journey was very agreeable. We walked for fome time along the banks of the Spey, which are here in-

cluded

cluded between great banks of boulder ſtones, that have been carried from the upper part of the glen. We ſoon left the banks of the river, and journeyed along by the foot of the hills that form the ſide of the valley; theſe hills are in general heath-clad, but often alſo preſent broken, rough, gray, ſurfaces, announcing them to be compoſed of micaceous ſhiſtus. This ſhiſtus appears in ſome places to be traverſed by granite veins, as I obſerved upon the road maſſes of a granite, whoſe conſtituent parts are of great ſize, ſimilar to that which is only to be found in veins. In ſome of the granite maſſes I obſerved pieces of micaceous ſhiſtus incloſed, ſimilar to the appearance of the bridge near Garvimore. Having walked near to the further extremity of Glen-Drummond, we expected that we were near to Dalwhiny, the next ſtage, but to our mortification, we found that we had taken a wrong road, being near to Pitmain on the Inverneſs road; we were therefore obliged to walk back for about 12 miles, and did not reach Dalwhiny until the afternoon. The ſtrata in this direction are ſtill primitive, and compoſed of micaceous ſhiſtus; and, in the beds of the rivulets, I often remarked it traverſed by granite veins.

Having refreſhed ourſelves after the long and circuitous walk from Garvimore, we ſet out for Dalnacardoch, as we wiſhed to reach it before the cloſe of the evening. The road

was

was good, and led through a valley bounded on both ſides by lofty heath-clad hills, which are in general of micaceous ſhiſtus. Their ſhape is lumpiſh, with ſteep ſides; and the ſtrata are only to be ſeen where the rains have worn deep ravines, owing to the thick covering of heath. At a turn of the road, where we met with the river Carie, the ſtrata are well expoſed, but are ſtill of micaceous ſhiſtus: but, upon the road, I remarked large maſſes of green hornblende, which approaches to actynolite; alſo, ſienite, which is compoſed of white felſpar, quartz, and hornblende: but I had not any leiſure to determine their ſituation with regard to the other ſtrata, as night was faſt approaching, and we were happy to reach Dalnacardoch after our tireſome journey.

As the weather ſtill continued extremely pleaſing, we ſet out early in the morning for Blair in Athol, which is the next ſtage to Dalnacardoch. The road continued for ſeveral miles thro' a dreary country, ſimilar to that which we had paſſed the preceding days, and the ſtrata were not much different; micaceous ſhiſtus, in ſome places alternating with blue-coloured granularly-foliated limeſtone, being the prevalent rock. A few hundred yards before we enter into a birch wood that ſtretches near to Blair in Athol, I obſerved a large ſtratum of felſpar porphyry? inclined at an angle of 45°, and reſting on, and covered by,

ſtrata

ſtrata of micaceous ſhiſtus, which have a ſimilar elevation. The ſtratum of porphyry, where I obſerved it, is from 12 to 15 feet wide, and is to be obſerved riſing to the tops of the hills on both ſides of the river; and, even at a diſtance, is eaſily diſtinguiſhable from the micaceous ſhiſtus, by its colour, and the peculiar manner in which it decompoſes. As we approach to Blair, the banks of the river become lower; and in ſeveral places I obſerved porphyry, but it was ſometimes difficult to determine whether it formed ſtrata or veins. The mountains now recede, and range themſelves on each ſide of the delightful valley which extends to Dunkeld: the banks of the river are ſkirted by natural wood, and to this immediately ſucceed lofty woods, that extend even to the ſummit of the hills. The country now increaſes in beauty every ſtep; and we are led, by a delightful road, thro' a rich diverſity of wood, to Blair, where there is a ſummer ſeat belonging to the Duke of Athol. The rapid change, from the brown, barren heaths of Dalnacardoch, to the richly-cultivated valley of Blair, is very ſtriking to the traveller; and it is farther pleaſing, from the probability that the other valleys, thro' which he has paſſed, may, one day, like the valley of Blair, attract admiration.

Having reſted a little, we took the charming road which leads to Dunkeld, through a valley that is not to be exceeded

for

for the richnefs, or the variety and beauty of its fcenery. The hills, which form the fides of the valley, are not of great height; and are, in general, formed of micaceous fhiftus, which has fometimes interfperfed cryftals of hornblende; yet there are alfo other rocks. Thus, a porphyry, fimilar to that which we have before obferved between Dalnacardoch and Blair in Athol, appears to form a confiderable hill among the micaceous fhiftus; but I regret that I had not leifure to examine their relative pofition. I alfo obferved maffes of fienite upon different parts of the road, and calcareous micaceous fhiftus. The micaceous fhiftus is fometimes to be obferved paffing into talcaceous fhiftus; and not unfrequently I obferved cryftals of hornblende fhooting thro' it. At Dunkeld, the hills are of confiderable height, and afford a confiderable variety of rock; but I fhall not at prefent ftop to mention them particularly. I may only remark in general, that I found micaceous fhiftus; this is to be obferved paffing, by various fteps, to chlorite fhiftus; and, laftly, the chlorite fhiftus is to be traced into ardefia. I alfo obferved much quartz penetrated with the chlorite, in various proportions; and frequently I remarked a granular quartzy rock, which has a bafis of chlorite.*

* As the country from Dunkeld to Dunbarton is frequently vifited by ftrangers, I will in this note mention a few facts with refpect to the general nature of the

We ſet out early in the morning for Perth; and on the road, at a little diſtance from Dunkeld, I examined a pretty extenſive quarry of roof ſlate, (ardeſia tegularis,) which is intermixed with chlorite, and beautiful ſpecimens of micaceous iron ore. I ob-

the rocks in that route. From Dunkeld to Taymouth the road is ſkirted by lofty mountains of micaceous ſhiſtus; and near to Taymouth there are quarries of talcaceous ſhiſtus, or lapis ollaris, which alſo afford fine ſpecimens of aſbeſtus. The rocks in the immediate vicinity of Taymouth are of micaceous ſhiſtus, but Mr Hatchett, with whom I made this journey, pointed out to me chlorite ſhiſtus paſſing into micaceous ſhiſtus, and the chlorite ſhiſtus approaching to lapis ollaris, and even making a paſſage into it. The micaceous ſhiſtus has frequently intermixed with it little rounded maſſes, having at firſt the appearance of garnets, but when cut with the knife, appear to be rounded pieces of the micaceous ſhiſtus. In the mountain we alſo picked up fragments of clay porphyry, but had not an opportunity of determining its ſituation with regard to the other rocks. From Taymouth along the banks of Loch Tay, the principal rock is micaceous ſhiſtus; and from the delightful retreat of Killin to the dreary and bleak Tyndrum we meet micaceous ſhiſtus, which is in ſome places ſtratified with limeſtone. At Tyndrum the mineralogiſt will be amuſed in examining the remains of the old lead mine. The next ſtages to Dalmally and Inveraray lead through a mountainous country compoſed of micaceous ſhiſtus, chlorite, &c. At Inveraray, there are quarries of lapis ollaris, and a conſiderable ſtratum of hornſtone porphyry, and this porphyry is covered by a ſtratum of marble. From Inveraray to Carindow, the rocks are principally of micaceous ſhiſtus. At Carindow there is a beautiful kind of ſienite, containing pretty conſiderable cryſtals of hornblende, and pink-coloured cryſtals of felſpar. From Carindow to Arrochar,

I obferved a breccia covering the micaceous fhiftus, thus announcing the termination of the primary ftrata; which we found to be the cafe. As the country now became much lower, its general appearance was quite changed; and to the ftrata of breccia, argillaceous fandftone fucceeded.

I now took leave of the Highlands, where I had fpent three months very actively; and have only to regret, that my little experience, and want of knowledge, in many important parts of mineralogy, may have caufed me to over-

rochar, through the wild Glen Croe, the mountains are principally of micaceous fhiftus. From Arrochar to Lufs, which leads along the charming banks of Loch Lomond, micaceous fhiftus is the principal rock that occurs. Ben-Lomond, the higheft mountain that rifes from the fide of the Loch, is compofed of micaceous fhiftus on its lower part, but, towards the fummit it is compofed of gneifs. At Lufs, there is a quarry of ardefia or primitive argillaceous fhiftus; here Mr Hatchett pointed out to me the diftinct gradation from indurated chlorite to chlorite flate, and from chlorite flate to ardefia. Maffes of porphyry are to be feen in different places; and a rock, which is compofed of rounded fragments of quartz, cemented by a bafis of chlorite, lies fcattered near to the quarry of ardefia. From Lufs to Dunbarton, we have not only a complete change in the appearance of the country, but alfo of the ftrata, as the primitive rocks near to Lufs are foon fucceeded by the fecondary fandftone, limeftone, bafalt, &c. which extend towards Dunbarton.

look interefting appearances, or to defcribe thofe, which I did obferve, but imperfectly, and probably, in fome inftances, without fufficient accuracy. But, if after travellers fhall experience as much pleafure in their journey as I did, they will have caufe to think their time ufefully employed.

The fecondary ftrata, which are principally fandftone and bafalt, continue to the flourifhing and pleafant town of Perth. In the neighbourhood of the town, is the hill of Kinnoul, which is remarkable for the charming profpect from its fummit, and the numerous beautiful pebbles of onxy, fardonyx, &c. which are found in a bafis of indurated wacken.

From this, by Kinrofs, to North Queensferry, the country is entirely formed of fecondary ftrata, as, fandftone, limeftone, bafalt, wacken, and greenftone; and in feveral places, as at Inverkeithing and St. David's, there are ftrata of coal, which are worked to a great extent.

A particular defcription of all this tract of country, from Dunkeld to the Frith of Forth, with an account of the coal

mines,

mines, would form a work that would afford much inſtruction and entertainment. The intelligent mineralogiſt would here have an opportunity of giving a minute deſcription of an extenſive Scottiſh coal-field, which would be an acquiſition of much value to geology.

[*I am happy to have it in my power to communicate to the public the following obſervations upon the mineralogy of the country between Fort-Auguſtus and Invernefs, which were politely communicated to me by Lord Webb Seymour and Profeſſor Playfair. In ſtrict order, they ſhould have been inſerted in a preceding part of this chapter, but the ſheet happened unluckily to be printed off before I was favoured with them.*]

THE road, ſoon after it leaves the Fort, aſcends, on the ſouth ſide of the lake (Loch-Neſs), into an elevated, mooriſh tract, and continues on this high level for many miles.

For the firſt five or ſix miles, the rock is all micaceous ſhiſtus, with a conſiderable admixture of quartz.

Riſing

Rifing from this high level, there are feveral hills, along the fides of which the road paffes: the valleys between are tolerably wooded. There are alfo a great many fmall lakes.

From about the point where the level begins to defcend toward the eaft, the micaceous fhiftus ends, and a granitic fandftone begins, which continues for a mile or two.

The river Fyers rifes on the right; and where the road firft comes on the banks of it, you fee micaceous fhiftus again, with a large dyke or vein of granite interfecting it.

We foon after come to granitelle, in great maffes, fome of it containing minute veins of much indurated fteatites.

This kind of rock continues till near the uppermoft of the two falls.

The high plain, in which we had been travelling all this while, is interefting, not only from its being on a level fo much above other plains, but becaufe the hills, that have their bafe in it, are of confiderable beauty, as well as wildnefs, with valleys between them, abounding in pafturage, and interfperfed with wood.

The

The Fyers runs, in the middle of the great valley, with much rapidity; the ground declines faſt toward the E.; the bed of the torrent rocky, and the banks wild.

The vale of Fyers opens into a meadow between fine granite rocks, before you come to the firſt fall, which is above a little bridge.

At this fall, the rocks are all of granite. The whole ſcene ſtriking and grand.

Below the bridge, which is cloſe to the fall, you ſee marks of the wearing and ſcooping out of the granite rocks, 30 or 40 feet above the preſent level of the river.

About a mile farther down, is the great fall, by which the river deſcends at once to the level of the lake. This fall has been often deſcribed: it could ſcarcely be ſeen in a more favourable ſtate than it was by us. The rock is ſtill granite.

From the General's Hut, a mile eaſtward of the fall, the rock is granite; but is ſoon, on proceeding eaſtward, ſucceeded by a pudding ſtone, containing large rounded blocks

of

of reddiſh quartz and of granite ſhiſtus, united by a cement of ſandſtone.

This pudding-ſtone begins at the firſt torrent beyond the inn, which runs in a very deep channel, and expoſes a fine ſection of the rock.

This pudding-ſtone accompanied us to near the end of the lake, when day-light forſook us, and prevented us from ſeeing diſtinctly the ſteps by which the highland country ſoftens down into the plain.

The ſtones that we picked up on the road continued, however, to be primitive, all the way to Inverneſs. At Inverneſs, the ſame continues; and the freeſtone uſed in building is brought from quarries on the ſea-ſhore not far from Elgin.

[It

[It is now several years since I wrote the following account of the Shetland Islands. *Since that time, I have been almost continually and actively employed in mineralogical pursuits; and have learned, at least, how very deficient this outline must appear. That knowledge of the subject, which enables a man to examine the mineralogy of a country with accuracy, is not merely the knowledge of fossils as specimens in a cabinet: it is to be gained only by an actual and very careful survey of different countries. This, I hope, will be my apology. I have republished this account, though imperfect, because these islands are remote, difficult of access, and interesting both to the geologist and the mineralogist.]*

SHETLAND ISLANDS.

CHAP. XXVI.

Outline of the MINERALOGY *of the* SHETLAND ISLANDS. *General Obſervations. Mineralogy of the* MAINLAND, FOULA, PAPA-STOUR, VEMENTRY, MUCKLE-RHOE, UNST, FETLAR, YELL, *and* WHALSEY.

THE Shetland Iſlands lie N. E. from Orkney, between lat. 59° and 61°. The neareſt are diſtant, from Buchan-neſs, 46 leagues; 16 or 18 leagues N. from the iſland of Sanda, one of the Orkney Iſlands; 6 or 7 leagues N. E. from the Fair Iſland; 58 leagues E. from the Faroe Iſlands, and nearly the ſame diſtance N. W. from the Lewis.

Theſe iſlands are very numerous, but few of them are of any conſiderable magnitude: thirty-three are ſaid to be inhabited, of which the largeſt is called the Mainland.

On

On a general view of thefe iflands, a wonderful fcene of rugged, bleak and barren rocks, prefents itfelf. No tree, nor fhrub, relieves the eye, in wandering over the dreary wafte. Sometimes, however, a few fcanty portions of cultivated ground catch the eye of the traveller, exciting emotions of pleafure, and forming a ftriking contraft with the barren heath-covered mountains which fkirt them. The weftern part prefents many fcenes, wild and fteril as can well be conceived; where grey rocks, rifing from the midft of marfhes or pools, and fhores bounded by awful fea-beat precipices, fuggeft to the mind ideas of defolation and danger.

The coafts are in general rugged and precipitous. Frequently the fcenes are truly fublime: vaft rocks, of various heights, dreadfully rugged and broken, oppofe their rude fronts to all the fury of a tempeftuous ocean; which in fome places has formed great detached pillars, in others has excavated grand natural arches and caverns, that mock all human magnificence.

The eaft fide of the Mainland (it is alfo the cafe in the other larger iflands) is comparatively low; but the weft is remarkably lofty, rugged and broken. Many of the mountains are fenfibly more fteep on the weft, than on the eaft fide. This

geological fact was long ago discovered by Dr Walker. It first occurred to him in the hills in the vicinity of Edinburgh; but he also found it to hold true in the Lomonds, and in all the other hills in the Highlands of Scotland. We also know that the west coasts of Scotland and of England have a gradual slope towards the east; and the course of all the great rivers, as the Spey, Tay, Tyne, Trent, and Thames, is from east to west. Upon examining other countries, the same phenomenon presents itself. Thus, the west coasts of Norway are precipitous, high and rocky. In the interior of Norway, the Lapland Alps present a precipitous west side, and the east shelves away, forming extensive plains. It is also very remarkable in the continent of America; where several of the largest rivers, as St. Laurence, La Plata and the Amazons run nearly from east to west.

Another observation may be made with regard to the hills—that they all run in the longest direction of the islands. This is a general fact, to be observed all over the globe. Thus, the mountains in Britain run from N. to S.; the Scandinavian mountains follow the same direction; as also the great ridges of the Norwegian and Swedish Alps. In America, the long-extended chain of the Andes runs from N. to S. which is the greatest length of the continent.

The

The hills in Shetland have feldom the ftrikingly rugged afpect of the ifland of Arran. They are greatly lower, and not fo much worn by rains and torrents: the principal fcenery of Shetland being produced by the action of the waves upon fea-coaft.

The hills are generally round-backed, running in ridges: fome approach to the conical fhape, and are detached. None are remarkably high: the higheft, which is Ronas Hill, is only about 1500 feet above the level of the fea.

To make general remarks upon the climate of a country, requires a long and careful feries of obfervations, with a multiplicity of apparatus, which few have an opportunity of obtaining: and although a good deal may be done by means of careful obfervation with the thermometer and barometer, the proper ufe of thefe requires no common fhare of fkill. To the exertions of the celebrated Mr Kirwan of Dublin, we are indebted for a great deal upon this fubject. With the liberality which characterifes a great mind, he has, at much expence, diftributed meteorological inftruments thro' Ireland; and we are now beginning to fee the good effects of his endeavours. In this diftant quarter of the globe, no accurate regifter of the weather has been kept; fo that all I can do, will be, to make

a few

a few general obfervations, which apply pretty generally to all the northern ifles of Britain.

The weather is extremely variable, there being a great deal of rain, and thick fogs, which occafion the lofs of many veffels on thefe terrible fhores. During the winter, there are confiderable falls of fnow, which lies, however, but a fhort time, on account of the vicinity of the fea. The frofts, which are feldom fevere, and never long, produce little inconvenience: were they to continue for any confiderable time, this fituation, already fufficiently dreary, would be comfortlefs indeed. The thermometer has been obferved 20° below the freezing point, but this continued for a very fhort time; a thaw foon followed, with hail, and violent gales of wind. Frequently, during the winter, dreadful ftorms prevail, particularly from the W. accompanied with thunder and lightning: an appearance feldom obferved at that feafon in other parts of Britain.

Many inftances might be mentioned, of the fatal effects, and extreme violence of the ftorms, which frequently happen among thefe iflands; but I fhall only mention one, which is ftill frefh in the memory of many.

During

During the three firft days of January 1784, it blew a violent gale, and continued with increafing violence until eight o'clock in the evening of the third day. The ftorm was fo furious, that the fea broke over headlands 120 feet high; and, at one place, a ftone, computed at 12 tons weight, which lay ninety feet from the fea, was raifed out of its place, and thrown two fathoms farther from the fhore. Many veffels were wrecked, and vaft quantities of fifh thrown upon the fhore. In the ifland of Moufa, I obferved many great maffes of fandftone, which had been torn off by the violence of the ftorm, and thrown far inland.

The aurora borealis, or what is ufually called ftreamers, illuminates the fky with uncommon brilliancy, and helps greatly to alleviate the gloom of the long winter nights.

MAINLAND.

THIS is by far the largeft of the Shetland Iflands, being about feventy miles long, and from twenty to half a mile broad.

The

The cliffs around the whole iſland are very rugged, but more ſo on the weſt than on the eaſt ſide; and the bays or voes, iſlands and rocks, are alſo more numerous on the weſt than on the eaſt coaſt.

There are few mountains of any conſiderable height, being generally from a thouſand to fifteen hundred feet high. Few of them are unconnected; but they generally run from N. to S. in the form of chains, having round-backed ſummits, approaching more or leſs to the conical form. Several conſiderable ridges can be traced along the whole of their courſe; and of theſe the moſt remarkable are the following:

1. *Cliff Hills.* This range commences oppoſite to the iſland of St. Ranens, where it is of conſiderable height, and runs by Scalloway to Deal-Voe, and from that to the ſea, where it becomes gradually lower.

2. A range, which has no particular name, riſes from Weſt-ſhore, and runs, with little variation in height, S. W. and N. E. to Lunneſting, terminating on the ſea-ſhore.

3. A range riſes upon the eaſt ſide of Weeſdale-Voe from Buneneſs,

Bunenefs, and runs from 16 to 18 miles, terminating on the fouth fide of Deal-Voe, in the parifh of Delting.

4. The higheft range rifes from the weft fide of Weefdale-Voe from Ruftanefs, and terminates at Frifkinefs in Delting.

The Mainland is divided into feveral parifhes, fome of them of confiderable extent: the parifh of Lerwick, which gives name to the principal village in the ifland, is the fmalleft. This village contains about 2000 inhabitants, and is built upon the fhore of Braffay Sound, which is near the middle of the ifland. The houfes in general are but indifferent; here and there, however, there are fome commodious dwellings: and they are built of fandftone and fandftone breccia, forming one ftreet, which is terminated by Fort-Charlotte. This fort was built during the time of Oliver Cromwell, and was for a long time in a ftate of ruin, until lately that it has been repaired at great expence, and garrifoned by a corps under the command of a captain.

Braffay Sound, which is the harbour of Lerwick, is one of the moft extenfive and fafe harbours in the Britifh dominions; and has its name, and is formed in part by the ifland of Braffay. This ifland is about 5 miles long, and between 2 and 3 broad, but very irregular in its fhape. It is high and rugged

on the S. and E. where it is much expofed to the action of the fea; but it is comparatively low on the W. and N. where it forms part of the found. The higheft hill, which is called the Ord of Braffay, forms, towards the fea, frightful precipices, feveral hundred feet high; all compofed of fandftone, fandftone flag and breccia: and the whole ifland is compofed of the fame materials. A great mafs has been feparated from the eaft fide by the violent action of the fea, and forms what is called the ifle of Nofs, remarkable for its tremendous cliffs and holm, where the natives encounter many dangers in fowling. This famous holm * is feparated about 34 fathoms from the ifle, and is perfectly mural on all fides, fo as to prefent a moft terrific afpect when viewed from below. Inacceffible as it appears, it has not prevented the daring iflanders from gaining its fummit, which exploit was performed many years ago, by a fearlefs fowler, who, having climbed to the top, drove ftakes into the ground, and ropes being thrown around them from the oppofite fide, were faftened to correfponding ftakes upon the bank of the ifland; a machine of wood, which they call

* Mr Pennant, in the elegant introduction to his Arctic Zoology, has given a drawing of Low's, which expreffes the appearance of the holm very indifferently. The holm is faid, by Mr Pennant, to be 480 feet in height: this is certainly too high.

call a *cradle*, was then faftened upon the ropes, fo that it could be pulled backwards and forwards: and in this way they go in queft of the numberlefs fea-fowl that inhabit thefe cliffs. The fowler who firft planted the ftakes, flufhed with his fuccefs, would not take advantage of the cradle, but, braving every aid, attempted to defcend, and was dafhed to pieces upon the rocks below. The ifland and the holm do not differ from Braffay in their compofition; being formed of fandftone, fandftone flag, and breccia: but the fandftone is of various colours, a confiderable extent of the cliffs being of a reddifh hue.

The oppofite fide of the found, where Lerwick is fituated, is compofed of the fame fandftone and breccia which we obferve at Braffay. The fort, already mentioned, forming one extremity of the town, is built upon a rock of breccia; which foon gives place to a horizontal ftratum of fandftone, running to the oppofite extremity of the town, called the Nab. The hills in the neighbourhood are not high, and are compofed of fandftone and breccia. This fandftone is the fame we obferve in all the other parts of the ifland. The breccia is compofed of fragments of red granite, micaceous fhiftus, quartz, felfpar, and green mica: the fragments are either rounded or angular; of various fizes, from that of a grain, to maffes of feveral hundred weight. The fubftramen, or bafis,

is hardly difcernible, excepting in large maffes, when a pafte is formed by the fmaller fragments. I alfo obferved, in general, that, where the fragments are large, the ftrata are diftinguifhed with difficulty, and are horizontal; but as the particles become fmaller, the ftrata are more diftinct and inclined.

The coaft, from Lerwick to Quarf, is compofed of fandftone: in fome places, however, there are great rocks of breccia, which have a very fingular appearance, owing to the immenfe fize of the concretions.

On this part of the coaft there are feveral extenfive caves. We rowed a confiderable way into one of them, then landed, and walked to its farther extremity. At the entrance, it is a natural arch, which becomes gradually lower until it is loft in darknefs, where nothing is to be heard but the dropping of water from the damp, black roofs, and now and then the filence is difturbed by the fnorting of feals, or the flutter of the pelicani or columbæ. But the moft beautiful part of thefe rocky fcenes, is the wonderful tranfparency of the water, which difclofes, to our view, rocks of various fantaftic forms, covered with the beautiful millepora rubra, and adorned with fuci of a great variety of colours. Thefe fuci, when moved by the gen-

tle

tle motion of the water, difcover numerous fpecies of fpongiæ, actiniæ and echini, of the moft exquifite colours, altogether forming an admirable fubmarine picture.

At Quarf, the ifland is only about two miles broad, forming the ifthmus which connects the fouthern parifhes with the mainland. It forms a kind of valley, which is bounded on both fides by mountains of confiderable height, compofed of micaceous fhiftus. Here, there is a fmall fifhing ftation, from which boats go to the *Haafe*, or fifhing ground, in fearch of tufk and ling.

The land from this again becomes broader, forming one fide of Æthvoe, and is compofed of fandftone, and breccia; in feveral places, however, there are confiderable ftrata of limeftone, which is worked for building and manuring the ground. This voe is a large open bay, having the flat and cliffs of Coningfburgh on the north and weft, with Sandlodge, and Moufa on the fouth. The cliffs of Coningfburgh, which form part of the range of hills that rife oppofite to St. Ranens, are compofed of micaceous fhiftus; and in feveral places it is to be obferved, with the common argillaceous fandftone covering it.

Among

Among the ſtrata of micaceous ſhiſtus, I obſerved beautiful ſpecimens of cryſtalliſed ſienite.

Having paſſed theſe cliffs, we come to Sandlodge, one of the ſeats of the ancient and moſt hoſpitable family of Bruce of Sumburgh. It is ſituated upon the ſea ſhore; having a pretty extenſive flat near it. At a little diſtance from the ſhore, in the ſandſtone, which is here ſtill continued, there is a vein of copper pyrites, or ſulphuret of copper, which was worked for ſome time, by a party of miners, from Wales, with very flattering proſpects; but the vein gradually decreaſed in width, until it was not above an inch broad, when it was thought proper to leave it †. On the oppoſite ſide of the houſe, there is another large vein of iron ore, above ſix feet wide, having a very ſcorified aſpect. This was alſo worked for ſome time, but the great expence, and the ſmall proportion of copper obtained, ſoon made it to be given up. The ſandſtone continues from this, all around to the bay of Sandwick, here and there interſected with calcareous ſpar, and much impregnated with oxyd of iron. Betwixt Sandlodge and Sandwick bay, lies the ſmall iſland of Mouſa, or Queen iſland, about

† I am happy to learn, that theſe mineral appearances have again attracted the attention of ſome Welſh miners, and they are now buſy raiſing the ore.

which is about a mile and a half long, and upwards of a quarter of a mile broad. It is rather low, compofed entirely of fandftone, and fandftone flag, with feveral ftrata of limeftone, which run in the fandftone from eaft to weft.

The whole coaft from Sandwick to Sumburgh head, the moft fouthern point of the ifland, is almoft entirely compofed of fandftone, and breccia, lying upon the mountains of gneifs and micaceous fhiftus, which run through this part of the ifland; there are alfo in feveral places confiderable ftrata of limeftone. From Sumburgh head, which is entirely compofed of fandftone, we have an extenfive and beautiful view of a great part of the Mainland, ifland of Braffay, and ftupendous Nofs; on the one hand the far diftant Fair ifle rifes gently in the horifon, and on the other the fecluded Fula forms a tremendous object. Below us we have a direful example of the blowing of loofe fand, or what is called the *Sand Flood;* for an eftate which belongs to Sinclair of Brue is now rendered a forlorn wafte, which, before this calamity, was one of the moft productive parts of the ifland. I could not learn the caufe of this difafter, but it was probably owing to the tearing up fome of the plants which are known to prevent the blowing of fand. This practice cannot be too feverely reprobated, when it is known that the confequences are fo pernicious; thus, in many of the Weftern

tern Iflands Dr. Walker has obferved, that if the fmalleft aperture be made in the fand, the flood inftantly commences; and we know that, in Suffolk, a quantity of fand, which at firft only covered about ten acres, has now fpread itfelf, and covers feveral thoufand. The fowing of plants, which grow in loofe fand, is the only remedy which can be recommended to ftop the baneful progrefs of thofe floods. Of thefe feveral have been recommended; but the moft efficacious, are the Galium luteum, Elymus arenarius, Triticum junceum, and Arundo arenaria; this laft the Dutch plant with great benefit. From Sumburgh head acrofs the large open Quendal bay, little is to be feen, except a few rocks of an extremely coarfe breccia, of the common kind. At the next head-land, Fitful head, the primary mountains make their appearance, without any covering of the fecondary breccia or fandftone, which difappears at one fide of Quendal bay, and is not to be obferved again until we come to Sandnefs hill on the north weft part of the ifland. This immenfe head-land is almoft entirely compofed of a lead-coloured micaceous fhiftus, of which the greater part is mica, in very minute fcales; and in the fiffures of the rock I obferved feveral fmall portions of micaceous iron ore. The micaceous fhiftus is here to be obferved paffing to chlorite fhiftus, and intermixed with the talcite of Mr Kirwan, and confiderable quantities of quartz. Below this at Garthnefs, there is a large in-

vein of fulphuret of iron, about feven feet thick, running in a ftone intermediate between micaceous fhiftus and chlorite fhiftus. It lies expofed to the day for twenty or thirty feet, and was worked for fome time, but was alfo given up.

The coaft from this all along the weft fide by Bigtoun to Scalloway, including Colfa ifle, and the ifland of Saint Ranens, is compofed of granite, micaceous fhiftus, chlorite fhiftus, talcite of Mr Kirwan and quartz.

The ifland of Saint Ranens is fmall, very rugged, and connected with the Mainland by a bank of decompofed micaceous fhiftus. Captain Prefton, in his chart of the Shetland Iflands, has placed this bank at one end of the ifland, in place of the middle. The coaft from this to Cliff Sound is very rugged, owing to its expofure to the Atlantic Ocean; but in the Sound the land is defended by the iflands of Houfe, Burra, and Trondray, and is neither rugged nor very abrupt.

The ifland of Houfe is about three miles long, narrow and flat, compofed of micaceous fhiftus, granite and quartz. Near to the north end I obferved a vein of granite two or three feet wide, running in the micaceous fhiftus; the granite had the

ufual appearance, and where in contact with the ftratified matter was not at all altered in hardnefs.

The ifland of Burra, which is feparated from the ifland of Houfe by a fmall found, is alfo more rugged on the weft, where it is much expofed to the action of the fea, and is compofed of granite, micaceous fhiftus and quartz.

The coaft and hills from Scalloway by Uftnefs Voe, Stromnefs Voe to Weefdale Voe, are compofed of the ufual alpine rocks. At Weefdale Voe there is a great ftratum of limeftone, which can be traced for feveral miles running in the micaceous fhiftus. All the hills in the neighbourhood are compofed of micaceous fhiftus, talcite and gneifs; this laft by decompofition forms a clay-like mafs, which the inhabitants ufe for fullers earth. A great fection of the gneifs is to be feen amongft thefe hills, in various ftages of decompofition *. From Weefdale through Æthfting and Sandfting, the alpine rocks continue,

* The late Mr Wedgewood, upon analyzing an earthy fubftance from Sidney Cove, New Holland, was led from feveral circumftances to conclude, that it contained a new earth which he called Sydneia. Lately, however, Mr Hatchet, in a paper read to the Royal Society of London, [has] demonftrated, in a moft

tinue, forming in many places confiderable hills, and upon the fea-fhore immenfe precipices of red granite. The fcenery upon this coaft is awfully grand; a great extent of coaft, dreadfully rugged and broken, prefents to our view vaft detached pillars, and numberlefs magnificent arches, through which the tides rufh with inconceivable fury, and the whole being tinged with a reddifh hue, produces a grand effect, when contrafted with the lurid appearance of a ftormy fky.

The next parifh, which is named Walls, I had but little opportunity of examining, fo that I can fay nothing with certainty of its compofition. In the neighbouring parifh of Sandnefs, the fandftone again makes its appearance at Sandnefs hill, which is of confiderable height. From this the coaft becomes gradually lower, and is in many places peculiarly fterile and iron-like; the land again rifes in height, and fo on alternately all around the ifland, forming many confiderable voes, with very magnificent pieces of fcenery, particularly the Doreholm off the parifh of North Maving, which is a vaft detached rock, perforated by a great natural arch, very fimilar

 to

moft fatisfactory manner, that this fuppofed earth is a compound of filex, argil, and oxyd of iron; and he fuppofes that it is derived from a decompofed granite, or gneifs, fimilar to what has been mentioned above.

to ſome of thoſe obſerved by Captain Cook among the South-Sea Iſlands. The immenſe rocks, the Oſſa, Skerries, and Ramna Stalks, preſent a moſt tremendous appearance in ſtormy weather: but to particularize the many rocky ſcenes, that occur around this iſland, would be foreign to my preſent purpoſe. I ſhall therefore conclude this ſketch, by remarking, that the rocks (ſo far as I have examined) are either granite, gneiſs, micaceous ſhiſtus, chlorite ſhiſtus, limeſtone, or ſandſtone; but I did not obſerve this laſt in any quantity till we came to the eaſt coaſt.

F O U L A *.

THIS iſland is about three miles along, and half a mile broad, ſituated in the Atlantic Ocean, about twenty-four miles from Main-

* As the Orkney Iſlands are viſible from the heights of Foula in clear weather, there can be little doubt of its being the Ultima Thule of Tacitus: that of Pythias the Marſeillian, who was contemporary with Ariſtotle, is thought, by Mr Pennant †, to be Iceland, while Dr Foſter ‡ is decidedly of opinion that it is ſome part of the Shetland Iſlands.

† Arctic Zoology, vol. i. p. lvii. ‡ Voyage to the North, p. 15, 30.

Mainland; holding the ſame ſituation with regard to Shetland, which St. Kilda does to the Hebrides. It contains but little level ground, being chiefly formed of three hills, of a nearly conical ſhape; the higheſt of theſe is between 800 and 900 feet in height. Here there is but one landing-place, and in bad weather it cannot be approached. The eaſt ſide, which is much lower than the weſt is compoſed of granite, micaceous ſhiſtus, and quartz. The micaceous ſhiſtus covers the granite; but in ſome places the ſea has waſhed it away, and left the granite expoſed, which is of a red colour, and is frequently traverſed with conſiderable veins of quartz. The micaceous ſhiſtus alſo contains neſts of green actynolite, and garnets are often diſperſed thro' it. The ſouth, weſt, and north ſides of the iſland are compoſed of ſandſtone, and ſandſtone flag, of the ſame ſpecies with that we have obſerved in the other parts of Shetland. Upon the weſt ſide there are moſt hideous precipices, inhabited by numberleſs ſea-fowl, which the people run incredible riſks in catching.

The account which Pontopiddan has given of the fowlers in Norway, is realiſed, and even exceeded by the inhabitants of this ſecluded ſpot. It is not many years ſince it was a common obſervation, that few died a natural death, being either drowned or daſhed to pieces among theſe terrible precipices: now

now they are more cautious, and comparatively few are deſtroyed.

PAPA-STOUR.

THIS iſland is of a very irregular ſhape, about a mile long, and half a mile broad, lying in the mouth of St. Magnus Bay, at a little diſtance from the ſhore of Mainland. It is low, but one of the moſt fertile of the Shetland Iſlands; and it has ſeveral tolerable harbours, of which Hamna Voe is the beſt: but the entry is difficult, on account of a great ridge of rocks, which runs acroſs the entrance. At Houſe Voe, which is the uſual landing-place in coming from Mainland, ſandſtone, ſandſtone flag and breccia form one ſide of the voe, which is low, and not rugged. In going round the iſland toward the next harbour, called Olis Voe, the ſandſtone diſappears, when a foſſil, nearly ſimilar to wacken, preſents itſelf, forming cliffs of conſiderable height, without any marks of ſtratification; and it continues with little interruption all around the iſland, until it meets with the ſandſtone ſtrata on the oppoſite ſide. From this, it appears, that theſe two genera of rock form the greater

greater part of the iſland. Several other foſſils, however, are to be obſerved, either in ſtrata below the wacken, in veins, or ſporadic. Thus, upon the north ſide of the iſland, the wacken lies upon a kind of breccia, much reſembling that of the Calton Hill, near Edinburgh. It is alſo traverſed by veins of different kinds, which run in different directions, and vary conſiderably in their magnitude. The following are thoſe which I obſerved. 1. Veins of greenſtone and baſalt: the baſalt ſometimes contains ſmall cryſtals of fluor ſpar. The appearance of fluat of lime in baſaltic rocks is rare; the only ſimilar inſtance I am acquainted with, is detailed in the 6th volume of the Journal des Mines, where it is mentioned that grains of fluor ſpar had been obſerved in a baſaltic rock. 2. Veins of ſemi-indurated ſteatites, which often contain hollow nodules of chalcedony and jaſper, which are lined with cryſtals of quartz. 3. Veins of red ſinople, which are intermixed with chalcedony and quartz.

I cannot diſmiſs this ſhort account, without mentioning, that various ſpecies of pumice are to be gathered in ſeveral of the voes of this iſland, and ſome of the pieces are of very conſiderable ſize. Similar kinds of pumice are got near the Giant's Cauſeway, in Ireland, and upon the ſhores of the Weſtern Iſlands, which volcaniſts have reckoned a very ſatisfactory

proof

proof of their chimera. An examination of the rocks would ſoon ſatisfy any one but a volcaniſt that theſe were adventitious matters. Accordingly, their origin is now plainly traced from the famous iſland of Iceland; and this is rendered the more probable, when we conſider, that many light ſubſtances are floated, from the Weſt India Iſlands, upon the ſhores of the Shetland and Weſtern Iſlands.

VEMENTRY.

THIS iſland is ſituated in St. Magnus Bay, at a conſiderable diſtance from Papa-ſtour. It is much interſected by the ſea, and riſes high in the middle, forming what is called the Wart of Vementry, upon the top of which there are the remains of a burgh. From this hill, we have a view of the whole iſland, and the adjacent coaſt of Mainland; than which nothing can be a more dreary proſpect.

From the ſhort time I was upon this iſland, I can only ſay, in general, that it appeared to be compoſed of granite, diffe-

rent

rent kinds of micaceous ſhiſtus, and a beautiful ſpecies of hornſtone porphyry, which I obſerved in various ſtages of decompoſition; in ſome ſpecimens the feltſpar appeared to be decompoſed firſt, in others the hornſtone.

MUCKLE-RHOE.

THIS iſland is about twenty-four miles in circumference, the eaſt and ſouth ſides are low, owing to their being defended from the violent action of the ſea by the Mainland, but the weſt ſide is very rugged and broken. From the little opportunity I had of examining it, I can only ſay that a conſiderable part appeared to be compoſed of granite. Another iſland in the ſame bay, called Papa Little, appears to be compoſed of granite and micaceous ſhiſtus, of various kinds.

UNST.

THIS is the moſt northern of the Shetland iſlands; it is about eight miles long, and from two to two and a half miles broad. Its form is that of a lengthened ſquare; the ſea coaſt is as uſual very rugged, and the iſland is hilly; the higheſt hill which is named Valley-field, is about ſeven hundred feet. There are two excellent harbours, Balta and Uyea Sound, which are often of the greateſt ſervice in ſheltering veſſels that paſs to and from the Greenland ſeas; but the firſt is generally preferred as being more convenient and ſafe. Balta Sound is a pretty deep inlet, formed into an excellent harbour by the iſland of Balta that lies acroſs its entrance, thus forming two paſſages; one from the north is rocky and only fit for ſmall veſſels, but the other from the ſouth will allow large ſhips to enter.

The hills upon the north ſide of this ſound are of conſiderable height, compoſed of ſerpentine, but preſent an extremely bleak and barren aſpect, owing to the iron-brown covering, which it acquires by the action of the weather. The ſerpentine is of a green colour, is frequently traverſed with ſmall veins of

of iron ore, and often affumes a fibrous appearance, forming what Wallerius calls talcite; a ftone very different however from the talcite of Mr Kirwan. It alfo contains lamellar actynolite, labrador hornblende, tremolite, and veins of fhiftofe talc traverfe it.

This ferpentine continues to form the hills and cliffs, until we arrive at the beautiful bay of Norwick, when a fingular ftriated micaceous fhiftus takes it place, forming one fide of the bay; this alfo conftitutes a great part of the coaft until a fpecies of gneifs (remarkable for the large fize of its cryftals of feltfpar) makes its appearance, the micaceous fhiftus which covered it being wafhed away. Near to this place an immenfe mafs has been feparated from the land, forming a great hollow called Saxes Kettle, from the fea rufhing through a narrow aperture at the bottom, which caufes it to boil up with great violence. *

* Here the Shetland Giant Saxe ufed to boil his prey, and terrify the affrighted natives; but more furprifing than this is a famous well at a little diftance, where the inhabitants fay their anceftors ufed to get boiled or roafted fifh, in proportion to the depth they went. This is a fact truly Plutonic, well deferving the attention of world makers.—*Brand's Hiftory of the Orkney and Shetland Iflands.*

The land from this runs out to form what is called the point of Lambanefs, equally fteep, but not fo high as the fides of the bay, and from this to the Sha, the moft northern point of the ifland, and of his Majefty's dominions, the gneifs continues, and does not difappear until we approach to the deep bay of Bura-firth, where the land becomes higher, forming lofty cliffs of micaceous fhiftus. At the bottom of this bay the land is low, prefenting beautiful rocks of undulated micaceous fhiftus †; but after croffing the bay we find the land rife gradually, forming the lofty cliffs of Hermonefs, which are compofed of fimilar rocks. At the bottom of thefe cliffs there are immenfe caves excavated by the fea, into which a boat can row many hundred feet in calm weather; the entrance is faid to be ornamented with regular octogonal pillars, but what their nature is I could not determine, as the furf prevented me from approaching. Is it probable that they are formed of gneifs? for there is no other foffil near but micaceous fhiftus. From this the whole weft coaft is very lofty and rugged, compofed of micaceous fhiftus, and this laft often contains extremely beautiful regularly cryftallized garnets of great

† This fpecies is entirely compofed of mica without any admixture of quartz, which Karften in his catalogue of the Lefkean cabinet reckons a rare production.

great ſize. As we approach the ſouth weſt extremity, the land becomes lower, and towards Belmont, the ſeat of Thomas Mouat, Eſq. of Garth, ſtrata of ardeſia, or primitive argillaceous ſhiſtus, are to be obſerved in the neighbourhood of the micaceous ſhiſtus. The ſerpentine now again makes its appearance, and forms in ſeveral places conſiderable hills, which have as uſual a barren and bleak aſpect. On the ſea ſhore, between Uyea Sound and the caſtle of Mounis, there are ſtrata of ſandſtone; and from this to Balta Sound the hills and ſhores are low, formed of micaceous ſhiſtus with a compound rock of green hornblende and quartz, and in ſome places we obſerve rocks of a compact feltſpar with hornblende.

FETLAR.

THIS iſland is about four miles long, and three and a half broad, of an irregular ſhape, owing to its being much expoſed to the action of the ſea. Its mineral productions are not very different from thoſe in Unſt; indeed it is probable that at one time they were joined. There are no harbours of any conſequence; the bay of Treſta is one of the largeſt, but is not ſafe

in

in ſtormy weather. One ſide of this bay is compoſed of micaceous ſhiſtus, quartz, in which large cryſtals of ſhorl are to be obſerved, with ſtrata of alpine or primary limeſtone. On the oppoſite ſide of the bay there are appearances of plumbago; in one place particularly there is a vein of a matter reſembling an impure plumbago, which is between two and three feet wide, running to all appearance in micaceous ſhiſtus. This latter foſſil forms the coaſt for a conſiderable way. It however diſappears, when immenſe cliffs of ſerpentine are to be obſerved, which often afford beautiful maſſes of rock cryſtal, alſo fine ſpecimens of aſbeſtus and amianthus. The ſerpentine, having formed a conſiderable extent of cliffs, diſappears, when a curious ſpecies of micaceous ſhiſtus preſents itſelf, compoſed of rounded maſſes of quartz, of conſiderable ſize, connected by means of mica, thus forming a rock not unlike to breccia. This rock, however, is only to be conſidered as a ſpecies of micaceous ſhiſtus, where the quartzy maſſes are of a greater ſize than uſual. Similar appearances, but not ſo ſtriking, have been obſerved in other countries: thus the great road which traverſes Moravia, is made, in the environs of Mark-Stannern, with a ſpecies of gneiſs, which has diſſeminated globules of quartz, about half an inch in diameter †. This curious

† Journal des Mines, No. 23. p. 69.; from Trebra's catalogue of foſſils.

rious rock forms a confiderable extent of cliffs ; but at Strand-burgh, a micaceous fhiftus, which feems paffing to ardefia, takes its place. This micaceous fhiftus alfo forms a confiderable extent of coaft, which is low, prefenting a moft fplendid appearance when the fun fhines, his rays being reflected from the micaceous rock as from immenfe mirrors. As the coaft rifes, the ferpentine again makes its appearance, having the ufual brown, iron-like afpect, and forming lofty cliffs upon the fhore ; but thefe continue only for a fhort way, when the micaceous fhiftus is again to be obferved, and continues forming low cliffs to the houfe of Urie. From this, round to the bay of Trefta, the coaft is lofty and precipitous, formed of micaceous fhiftus ; but at one place there are immenfe cliffs of gneifs, which, by decompofition, form a matter fimilar to that obferved at Weefdale Voe, which is here alfo ufed as fullers earth.

YELL.

THIS ifland is about 4 miles from Mainland, is about 16 long, and 8 broad, and is, next to Mainland, the largeft in

Shetland,

Shetland. There are ſeveral harbours, but none of them large or commodious. It is in general pretty hilly, very much covered with peat moſſes: this, with its tremendous broken coaſts, renders the iſland wild and gloomy. The hills, as far as I could determine, are compoſed of granite, micaceous ſhiſtus, and quartz. On the weſt ſide, which is extremely broken and rugged, there are ſeveral veins of granite, about 5 or 6 feet wide, that run in the micaceous ſhiſtus. They are ſometimes much curved, but generally run at an angle of about 70°. The granite is compoſed of quartz, felſpar, and mica; but all theſe are larger than in the granite which is found in ſtrata.

In ſeveral places I obſerved bitumen, ſticking upon ſtones, or floating in ſmall ſpring wells.

WHALSEY.

THIS iſland is about 6 miles long, and 4 broad, and is 3 miles diſtant from Mainland. The ſhores are low on both ſides, and,

as

as far as I could obferve, compofed of micaceous fhiftus and granite. The higheft hill is the Wart, which I found to be compofed of micaceous fhiftus to the top.

At a confiderable diftance lie the Grief and Out-Skerries; dreary and defolate rocks, inhabited by a few fifhermen, and compofed of the fame materials as Whalfey.

SHETLAND ISLANDS.

CHAP. XXVII.

Deſcription of the Fossils *mentioned in the preceding Chapter.*

CIANITE.

Sappare, Kirwan. *Blauer Talc*, *Glimmer*, *Schorl*, Germanor.

Colour. White, finely tinged with azure blue. The detached cryſtals reflect a ſilver-white light.

Crystallization. Is cryſtallized in the form of compreſſed priſms, more or leſs ſeamed acroſs. Preſents two narrow, and ſlightly ſtreaked, and two broad and ſmooth ſides. The cryſtals are frequently diſpoſed in a radiated form.

Croſs Fracture. Striated, and deſtitute of luſtre.

Longi-

Longitudinal Fracture. Foliated, with a luſtre like that of cryſtals, or metals not much poliſhed.

Hardneſs. When ſtruck parallel to its length, yields difficultly to the knife; when perpendicular to its length, gives fire with ſteel: ſcratches glaſs.

Specific Gravity. 3.618.

Becomes electric by friction, and this electricity is negative.

Another ſpecies of this beautiful foſſil was diſcovered many years ago at Botrephny in Banffſhire, and it has ſince been diſcovered in various parts of Europe. Mr. Werner thinks that it is nearly allied to the indurated talc, and that it makes an intermediate foſſil between talc and hornblende.

WACKEN—*Papa-Stour.*

Colour. Brick-red of various ſhades, alſo dark-brown.

Luſtre and Tranſparency. None.

Fracture. Smooth, earthy; but, when compact, it has a tendency to the fine ſplintery.

Fuſibility. Melted at 120° of Wedgewood.

It frequently contains felfpar, forming a fpecies of porphyry; fometimes it is intermixed with green earth: it often alfo is cellular, and the cells are encrufted with dark-brown chalcedony, covered with cryftallized quartz; and nodules of onyx and fardonyx are fometimes found in it.

Common SERPENTINE *.

Colour. Blackifh green.
Luftre. None, or faint glimmering.
Tranfparency. A little at the edges.
Fracture. Sometimes fine, fometimes coarfe fplintery.
Hardnefs. Yields with difficulty to the knife.

This foffil is ufed in many countries for the building of ovens, as it refifts the action of the fire very much; and, when powdered and burnt along with potter's clay, it can be made into

* Werner has lately divided the Serpentine into two kinds, the Common and Noble Serpentine: the laft mentioned has a conchoidal fracture, with a greater degree of luftre and tranfparency, and has generally a finer green colour than the firft.

into light, ſolid veſſels, which take a fine glazing, and reſiſt the fire very well. In Italy it is uſed for the fineſt buildings. What the Italians call the Verde antico, is the noble ſerpentine mixed with marble or granular limeſtone.

Lamellar ACTYNOLITE—Kirwan.

This correſponds with the ſpecimen I examined in the Leſkean cabinet at Dublin, from which Mr Kirwan's deſcription is taken. It appears to be an intermediate foſſil between actynolite, or ſtrahlſtein, and hornblende.

Common TREMOLIT.

Asbestinite, Kirwan.

Colour. Pale green.

Luſtre. Silky.

Tranſparency. A little at the edges.

Fracture. Broad ſtriated, the ſtriæ frequently diverging as from a centre. Its fracture alſo preſents diſtinct concretions, and it is from theſe that the ſtriæ appear to diverge.

Hardneſs. Yields eaſily to the knife.

By decompoſition it acquires an iron-brown colour.

Mr

Mr Kirwan found that this fpecies melted into a green glafs at 150° Wedgewood; and Klaproth has lately found, that, in a coal crucible, it gives a greyifh-white, opaque flag, with the lofs of 0.05; and in a clay crucible a compact greenifh-white flag is formed. He finds that two parts contain,

Silex,	-	-	0.65
Lime,	-	-	0.18
Magnefia,	-	-	0.103
Carbonic acid and water			0.065
Oxyd of iron	-	-	0.005

The phofphorefcence of the tremolit is very remarkable, and it has been found that the degree of effect is inverfely as their hardnefs: thus the foft filky fpecies gives a more vivid and red light, with a lefs degree of friction, than the harder kind. The phofphorefcence can even be produced by means of a feather.

SCHILLER SPAR, or

Labrador Hornblende.

This beautiful foffil is found in the ferpentine rocks of the ifland of Unft. It was firft difcovered on the coaft of Labrador;

dor; afterwards in Germany; and ſince in Cornwall, by Mr Hatchett. It is conſidered to be nearly allied to mica and talc; indeed it paſſes, on the one hand, into green mica, and, on the other, the yellow varieties paſs into common talc.

MICA

Is found in ſeveral of the Shetland Iſlands; and ſometimes the plates are of conſiderable ſize; but they are not ſo large as thoſe that I have ſeen brought from Ruſſia. A conſiderable quantity of mica is uſed in the Ruſſian navy, for the making of lanterns and cabin windows. It is preferred to glaſs, from its not breaking by the diſcharge of cannon. It has a conſiderable inconvenience, however, that it ſoon loſes its tranſparency by the action of the air and ſea-water.

As there are ſeveral foſſils that have a very near reſemblance to mica in their external appearance, I will here ſhortly ſtate the characters by which they may be readily diſtinguiſhed, as ſtated by the Abbé Huay *.

Mica

* Journal des Mines.

Mica is diſtinguiſhed from talc, by its communicating, by rubbing, the reſinous electricity to wax, while talc communicates the vitreous; and farther, mica has not the unctuoſity of talc. It is diſtinguiſhed from cyanite, by its ſoftneſs; the cyanite being vaſtly harder. It may be confounded with ſulphure of molybdæna; but the ſulphure of molybdæna foils paper, while mica does not: the ſame diſtinction with regard to carbure of iron. It is diſtinguiſhed from the green cryſtallized uranite, by its pliability, the uranite being very fragile: the blow-pipe alſo affords a good diſtinction, the mica being converted into enamel, while the uranite is changed into a black ſcoria. The greyiſh-black mica may be confounded with the micaceous iron ore, or eiſenman; but the latter is friable, and adheres to the fingers, often acts on the magnet, and melts into a black ſcoria.

ORK-


MAP
of the
Orkney Islands
for Outline of their
MINERALOGY
J. Menzies sculpt
THE NORTH SEA
North Ronaldsha
Westra
Sanda
Eda I.
Rowsa
Egilsha
Stronsa
Shapinsha
PAMONA or the MAIN LAND
KIRKWALL
Strom Ness
HOY
Burra
Flota
South Ronaldsha
Copinshaw
PENTLAND FIRTH
Dunnet Hd.
Men of Mey
Johny Groats house
Duncansby Hd.
Dunnet Bay
CAITHNESS
British Miles
Min. East fr. Edin.

ORKNEY ISLANDS.

CHAP. XXVIII.

Outline of the MINERALOGY *of the* ORKNEY ISLANDS; *comprehending* FLOTTA, SOUTH RONALDSHA, BURRA, POMONA, SHAPINSHA, STRONSA, SANDA, EDDA, WESTRA, EGLISHA, ROUSA, *and* HOY.

HAVING, in my former journeys, traverfed the greater part of the Scottifh Ifles, I was anxious to vifit the Orkneys, and thus to make my tour more complete; and therefore, laft fummer, 1799, I embraced the opportunity of a veffel going to the ifland of Hoy, and failed from Leith upon the 9th of June. The weather, however, proved ftormy, and the wind contrary, fo that we did not reach Orkney until the 20th, heartily tired of our voyage.

As ſoon as the veſſel anchored, we landed upon the iſland of Hoy, immediately below the houſe of Mr Bremner, the miniſter of the pariſh, who received us very kindly. Having breakfaſted, Mr Bremner was ſo good as to accompany us to the Berryhead, which is one of the moſt tremendous rocky precipices in Orkney. The walk was at firſt pretty eaſy; but as we came higher up the hill, it was fatiguing. Having reached to the ſummit of a high hill, we had ſtill to aſcend a conſiderable height, which brought us to the Berryhead. Here, indeed, a moſt ſublime ſcene burſt upon our view. Below us, and extending along the weſt coaſt of the iſland for ſeveral miles, were tremendous precipices of red-coloured ſandſtone, which roſe to a great height. We crept towards the edge of the precipice, and beheld with terror a perpendicular deſcent of more than 1000 feet deep. When our attention could be withdrawn from the ſight of theſe vaſt precipices, a ſcene of a different kind preſented itſelf to our view. The ſky was clear; the ſea calm, and ſtill as a lake; and the whole extent of the ſea, and Pentland Frith, from Cape Wrath to Duncanſbay Head, was before us: the wild mountains of Sutherland and Caithneſs, of an etherial blue, added to the grandeur of the ſcene, retiring from the eye till at length they ſeemed to be blended with the ocean. We returned to the manſe, well pleaſed with our excurſion;

excurſion; but found no variety of rock, ſandſtone being the only rock we obſerved.

We remained at Mr Bremner's all night, and took a boat next day for the iſland of South Ronaldſha; but, in our way, examined the ſmall iſland of

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FLOTTA.

THIS iſle is of little extent, low, but in ſeveral places there are cliffs upon the ſea-ſhore which are of conſiderable height. It is entirely compoſed of ſandſtone and ſandſtone flag; nor is it remarkable, excepting for its former celebrity, being the reſidence of the hiſtoriographer appointed by the crown of Norway to collect information with regard to the north of Scotland. Theſe narrations formed a work called Codex Flotticenſis; to which Torfæus is indebted for much of his hiſtory of the northern parts of Scotland.

We croſſed from this iſle to the iſland of

SOUTH RONALDSHA.

THIS iſland is about ſeven miles long, and one and a half broad. It is low, excepting upon the ſhores, where there are tremendous precipices, which have proved fatal to many an unfortunate mariner. The whole iſland is compoſed of ſandſtone, ſandſtone flag, and in ſome places ſhiſtoſe clay is to be ſeen. It appears, like all the other Orkney Iſles, to have been formerly joined to Caithneſs, as the ſtrata are ſimilar. Mr Watſon, the miniſter of the pariſh, told me, that the ſandſtone, in different parts of the iſland, has been dug, in expectation of finding good veins of lead ore (galena), but always without ſucceſs. This is very probable, for Emmerling informs us that ſandſtone is very unfavourable to ores *. (Mineralogie, B. 3. S. 119.) In one part of the iſland we obſerved a ſtratum of ſhell marl lying under the peat, and in differents parts of the iſland we obſerved bog-iron ore.

As

* It is ſaid, however, that the mountain Verſopatal, in Mexico, is compoſed of ſandſtone, which is traverſed by numerous veins, in which gold is found ; Gerhard mentions ſimilar rocks.

As the weather was boifterous, we remained in this ifland feveral days; at length the wind fubfided, when we were enabled to crofs to the ifland of

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BURRA.

THIS ifland is of little extent, low, and compofed of fimilar argillaceous fandftone with that of Ronaldfha; and in one place I obferved ftrata of fhiftofe clay alternating with it. The fhiftofe clay is of a black colour, and has frequently interfperfed bitumen; and veins of calcareous fpar are to be obferved traverfing it. This is a favourable appearance for coal, and deferves to be tried.

As this ifland afforded nothing particularly interefting, we croffed to the Mainland, or what is called the ifland of

POMONA.

THIS iſland is about 22 miles long, and in ſome places about 20 broad. It is in general low; the hill of Wideford, near to Kirkwall, and thoſe in the pariſh of Orphir, being the higheſt in the iſland. The ſhores in ſome parts of the iſland are pretty high, yet in general they are low. There are two good harbours: the one at the principal town, called Kirkwall; the other upon the oppoſite ſide of the iſland, at Stromneſs.

The mineralogy of this iſland is by no means intereſting; the whole of the iſland, excepting a ſmall portion near to Stromneſs, being entirely compoſed of ſandſtone, ſandſtone flag, ſhiſtoſe clay, and in one place limeſtone and baſalt make their appearance. The ſtrata are generally horizontal, and are of various breadths; and the ſandſtone and ſhiſtoſe clay alternate with each other. As it would be of little conſequence to trace my ſteps in the walk which I made around this iſland, I ſhall mention only the peculiarities of the different rocks.

1. *Sand-*

1. *Sandſtone.* This rock is of various colours, grey, red, or whitiſh; has generally an argillaceous cement: yet, in particular kinds, this is but in ſmall quantity. It is frequently ſhiſtoſe, forming ſandſtone flag. It is uſed for building in all parts of the iſland; and in ſome places, as at Skail, where it is very hard, being a ſiliceous ſandſtone, it is cut for mill-ſtones, and is ſaid to anſwer the purpoſe very well. A ſtratum of ſiliceous ſandſtone, ſimilar to that at Skail, I obſerved among the ſoft ſandſtone ſtrata near to Scapa; and I have not the leaſt doubt, if well quarried, that it would anſwer equally well for mill-ſtones *. Sometimes maſſes of iron pyrites, of a globular or irregular form, are diſperſed through it; and of this

* Different kinds of rock are uſed in Scotland for the making of mill-ſtones. Thus, in ſome places, as in the iſland of Raſay, I found porphyry uſed for mill-ſtones; and in Shetland, a compact ſpecies of micaceous ſhiſtus, is uſed for the ſame purpoſe. It has been a great deſideratum to diſcover in Great Britain, a mill-ſtone equal to the French bur; indeed it is of ſuch inportance, that, the Society for the Improvement of Arts and Manufactures, at London, have offered a reward of 100 guineas, to him who ſhall diſcover a ſimilar rock in Great Britain. As this rock may not be generally known, I think it proper here to mention that it is a cellular hornſtone, and is found in vertical ſtrata, according to Wallerius. As this famous ſtone is of a porous nature, and very hard; it is very probable that theſe properties muſt reſide in all good millſtones.—See Townſon's Tracts, paper on Mill-ſtones.

this we have an example in the ſandſtone rocks upon the ſhore between Scapa and Orphir kirk. Trials have been made in the ſouth part of the iſland with a view to find lead, but without ſucceſs. At Yeſtneby, near to Skail, I obſerved veins of barytes traverſing the ſandſtone; and, intermixed with this barytes, there was calcareous ſpar, iron pyrites and galena. At Skail, the ſandſtone, by the action of the weather, ſplits into many ſingular forms, ſimilar to the ſandſtone I have deſcribed in the iſland of Arran.

2. *Shiſtoſe Clay.* This rock has a black colour; is always intermixed with mica; and paſſes, on the one hand, into ſandſtone ſlate, and, on the other, into clay, where the ſhiſtoſe character is more difficultly diſtinguiſhable. It acquires, by the action of the weather, an iron-brown covering; ſo that the rocks, at a diſtance, have much the appearance of the weathered ſerpentine rock in the iſlands of Unſt and Fetlar, in the Shetland iſlands. In ſome places, as near to Stromneſs, I obſerved a red-coloured clay, which ſeemed to be clearly derived from the decompoſing ſhiſtoſe clay. It is quarried to a conſiderable extent in different parts of the iſland, particularly near to Stromneſs, and the ſlates are uſed for roofing houſes; but they are vaſtly inferior, in every reſpect, to the ardeſia which is raiſed at Ballyhuliſh and Eaſdale.——Upon the ſea-ſhore, near

to

to Brinnigar manſe, which is about a mile from Stromneſs, in a kind of rock intermediate between ſhiſtoſe and indurated clay, there are many pieces of galena diſperſed. Several years ago, a party of miners examined this appearance, and, having judged it probable that lead would be found in abundance, continued working for ſome time, but at length deſiſted, having, as they ſay, found it not worthy of farther labour. Near to the manſe of Brinnigar, I obſerved maſſes of Lydian ſtone immerſed in the ſhiſtoſe clay: in the Lydian ſtone there were ſeveral cavities filled with bitumen.

3. *Limeſtone.* At Yeſkneby there is a conſiderable ſtratum of black-coloured limeſtone, which alternates with a rock intermediate between ſandſtone flag and ſhiſtoſe clay. It is much impregnated with bitumen, forming what is called ſtinkſtein; and in ſeveral places I obſerved maſſes of bitumen diſperſed through it.

4. *Baſalt.* At Yeſkneby is the only baſaltic rock which I obſerved in the whole iſland. It forms veins, which traverſe the common argillaceous ſandſtone. The cryſtals of hornblende, which are contained in it, are larger than uſual in ſuch rocks, being more than an inch long, and half an inch broad. I ſometimes obſerved ſmall cavities filled with bitumen.

 The

The rocks of fandftone, fhiftofe clay, &c. which I have juft defcribed, form the whole ifland, excepting an extent of a few miles around Stromnefs, which is of primary ftrata. Thefe ftrata are, granite, gneifs, micaceous fhiftus, and hornblende rock; and all are traverfed by veins of great-grained granite. The granite feems to form the central part, and is covered by gneifs, micaceous fhiftus and hornblende flate. At the mill water of Cairfton, which is not far from Stromnefs, I obferved the junction of the primary with the fecondary ftrata. The micaceous fhiftus is covered by a breccia which is compofed of fragments of granite and quartz, cemented by a bafis of fmaller particles of the fame rocks; and, in the breccia, I obferved pieces of galena immerfed. This breccia is to be obferved, in fome places, covered by the fhiftofe clay. From fome appearances in the neighbourhood of Brinnigar, it is not very improbable that the fhiftofe clay may lie upon the primary rock, without any interpofed ftratum of breccia?

Having feen every thing that was worthy of notice, we croffed to the ifland of

SHA-

SHAPINSHA.

THIS iſland is about 7 miles long, and 5 broad. The ſhores around the whole iſland are in general low.

The ſtrata do not differ from thoſe of Pomona; being principally compoſed of ſandſtone, ſandſtone flag, ſhiſtoſe clay, limeſtone, and baſalt. The limeſtone is covered by a very hard, nearly ſiliceous ſandſtone, and it is alſo traverſed by veins of the ſame ſandſtone. The baſalt, which is only to be obſerved at the ſouthern extremity of the iſland, ſeems to be covered with ſandſtone. In the ſandſtone iſles of Copinſha, which lie at the ſouthern extremity of the Mainland, or Pomona, I alſo obſerved a baſalt, or rather wacken, traverſed by veins of horn-ſtone, and covered by a very hard ſandſtone: theſe, with the baſalt veins at Yeſkneby, are the only appearances of baſalt which I have obſerved in the Orkney Iſlands.

As this iſland afforded nothing intereſting, we ſailed for the iſland of

STRONSA.

THIS iſland is about ſix miles and a half long, and ſix miles broad. It is low, but upon ſeveral parts of the coaſt there are cliffs of conſiderable height. The rocks are entirely of ſandſtone and ſandſtone flag; which latter ſometimes paſſes to ſhiſtoſe clay.

Having ſpent two days in traverſing this iſland, we croſſed to the iſland of

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SANDA.

THIS iſland is about 12 miles long, and in ſome places nearly 3 miles broad. Upon the weſtern extremity there are hills about 300 feet high, but all the other parts of the iſland are low and flat. Large ſhoals extend a great way from the coaſt, which is one of the cauſes of ſo many veſſels being wrecked upon this iſland.

The

The mineralogy, like that of all the other iflands, is very uninterefting; it being, as far as I examined it, compofed entirely of fandftone and fhiftofe clay; excepting a rock of fandftone breccia, which I obferved at a place called Hecla-bor: hence the rock has been confidered as volcanic.

Having fpent feveral days in traverfing this ifland, we croffed to

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EDDA.

THIS ifland is about 7 miles long, and in fome places about 2 miles broad. It is hilly, and, like Sanda, entirely compofed of fandftone, which is of a red colour.

We croffed from this to the ifland of

WES-

WESTRAY,

and landed at the hofpitable manfion of Mr Stewart of Brough. This ifland is about 9 miles long, and 6 broad. It rifes, in fome places, to a confiderable height; and upon the north-weft part of the fea-coaft there is very magnificent rocky fcenery. It is entirely compofed of fandftone and fandftone flag; fo that to a mineralogift it affords no variety.

PAPA-WESTRAY.

ABOUT two miles north from Weftray, is the fmall, but pleafant ifle of Papa-Weftray. It is about three miles and a half long, and about a mile broad. It is principally compofed of fandftone, fandftone flag, fhiftofe clay, and in fome places I obferved fragments of breccia.

We now croffed, by a dangerous ferry, nine miles in breadth, called Weftra Frith, to the fmall ifland of

EGLI-

EGLISHAY,

where we were very kindly received by Capt. Baike. It is about two miles and a half long, and one broad; and is entirely compofed of fandftone and fandftone flag, and in fome places the ftrata feemed to be very much elevated.

As the weather was ftormy, we could not leave this ifle for feveral days: it having become more moderate, we croffed to the ifland of

RONSAY.

THIS ifland is about four miles long, and three broad, and, excepting Hoy, is the moft hilly of the Orkney Iflands. The coaft, in fome places, is of great height, and prefents many fublime rocky fcenes. It affords no variety of foffils, being, like the other iflands, entirely compofed of fandftone and fandftone flag; which laft fometimes paffes to fhiftofe clay.

Having

Having traverſed the whole of this iſland, we croſſed again to Pomona, and walked by Stromneſs, and again croſſed to the iſland of

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H O Y.

THIS iſland is about 12 miles long, and 5 broad; is the moſt mountainous of all the Orkney Iſlands; and its ſhores, as I have already remarked, riſe, in many places, to a moſt terrific height. This iſland is remarkable for its excellent harbour, called the Long-Hope, where great fleets can rendezvous, and in complete ſafety.

This iſland is entirely compoſed of ſandſtone, ſandſtone flag, ſhiſtoſe clay, and in many places I obſerved a rock of wacken. The ſtrata are generally horizontal, and ſometimes they alternate. The ſandſtone has been dug, in various places, in ſearch of iron ore; and the attempts ſeem to have been attended with ſome ſucceſs, as rich hematitical iron ore was obtained. I am of opinion, however, that, in the trials which have been made

made near to Melfetter, upon the eftate of Major Moodie, the proper bed of ore has not been fairly difcovered; and that which has been obtained, is merely an admixture of fandftone and ore. In other countries, this admixture, of the ore and the ftratified matter, has been taken for the true bed, and much unneceffary expence incurred, which might have been avoided by digging in a proper direction, fo as to meet with the bed of ore. The fhiftofe clay, where it alternates with the fandftone, has fometimes that fhining appearance which is characteriftic of the fpecies found above, or in the vicinity of, coal ftrata: a circumftance which is to be confidered as favourable for the difcovery of coal in the lower parts of this ifland.

The wacken, which I have mentioned, is upon the feafhore, at a little diftance from Melfetter. It has, intermixed with it, calcareous fpar, either in little veins or nodules: pieces of filicious fandftone are found in it, and even veins of a fimilar fandftone traverfe it.

We now took leave of Major Moodie, and failed down the harbour of Long Hope to the ifland of Ronaldfha, where we fpent a few days very agreeably with Mr Watfon, waiting favourable weather to crofs the Pentland Frith.

ON KELP.

CHAP. XXIX.

Obſervations on KELP.

AS this ſubſtance is of the greateſt importance to the Orkney Iſlands, I hope the following obſervations will not be conſidered as out of place.

This uſeful material does not appear to have been known as a manufacture in Britain, until ſome time after the beginning of the preſent century; owing to the backward ſtate of the ſoap and glaſs manufactures, which, particularly in Scotland, have not been carried on with ſpirit above thirty years. It will not then ſurpriſe us, when we learn, that its firſt intro-

duction

duction was about the year 1730, into the iſland of Uiſt, by a Highland gentleman, of the name of M'Leod, who brought the art from Ireland, where it had been carried on many years before. The method he followed was a bad one, as he was ſatisfied by merely reducing the ſea-ware, or fuci, to aſhes. This practice was ſoon diſcontinued, and the method of fuſion was adopted. This manufacture ſoon found its way into all the other iſlands; for we find it forming an article of trade in Shetland, ſoon after its introduction into the Hebrides. The quantity of kelp, at firſt made, was trifling; but the great increaſe, and the rapid progreſs, of the manufactures depending on it, ſoon raiſed the price and increaſed the quantity: the following being, as far as I can collect, pretty nearly the price of kelp from the year 1740 to the preſent time.

From 1740 to 1760, average price about			2l. 5s. a ton.
1760 to 1770	-	-	4l. 4s. a ton.
1770 to 1780	-	-	5l. 0s. a ton.
1780 to 1790	-	-	6l. 0s. a ton.

Since the year 1791, its value has greatly increaſed, and has now riſen to a greater height than was ever known before, owing to the war, which has prevented the importation of the

 uſual

ufual quantity of barilla, and has thus raifed kelp to the enormous price of 11l. a ton *.

In Shetland, from 250 to 300 tons are made annually, but this quantity bears fo fmall a proportion to the extent of the lands, as not to have affected the rent in an equal degree to that of Orkney; where, within thefe feven years paft, fmall farms of about 40l. yearly rent, have rifen to 300l. a year.

In Shetland, the coft of manufacturing is from 2l. to 2l. 10s. a ton; but in the weft Highlands, the price of labour is greatly lower, being from 1l. to 1l. 10s. a ton. The method of manufacturing, though rude, is fufficiently fimple. The different fpecies of fuci, particularly the veficulofus, ferratus, and nodofus, are cut from the rocks in the months of May, June, and July, and fpread out and dried fo as to enable them to burn more eafily. In drying the ware, they are very cautious to prevent any fermentation from taking place, or to fuffer it to be expofed to rain; as kelp, made from fuch damaged ware, is neceffarily of a very inferior quality.

The

* Even this price might be ftill further increafed in a very confiderable degree, if proper methods of manufacturing the kelp were followed.

The ware being well dried, a ſmall quantity is kindled in a pit dug in the ſand, or upon a piece of ground which is ſurrounded with looſe ſtones, ſo as to form what is called a kiln. They continue adding freſh quantities, until the pit or kiln is nearly filled, when the whole is frequently ſtirred towards the evening, when it gets into a ſemifluid ſtate; it is allowed to cool, and afterwards taken out of the pit ready for the market. This method of burning the ware, is liable to many inconveniences. Of theſe, the following are not the leaſt conſiderable: 1. As the ſides of the kiln become heated, conſiderable maſſes of ſtone ſplit off, and are mixed with the melted matter, which reduces the value of the kelp very much. 2. From the heat not being ſufficiently confined, the ware is always very imperfectly burnt. 3. By the fuſion being made upon the ground, a very conſiderable portion of ſiliceous earth is mixed with the melting materials; and this earth uniting with the alkali, renders a portion of it uſeleſs; becauſe, though it increaſes the weight of the kelp, it deteriorates its quality.

Theſe facts engaged the attention of my father ſome years ago, who endeavoured, by a ſeries of experiments, to aſcertain the value of kelp burnt in this rude way, and that made in furnaces. He erected ſeveral different kinds of furnaces, in which he burnt the ware, and afterwards examined the kelps; which

were

were very ſolid; free of foreign earthy ſubſtances of maſſes of carbonaceous matter; and contained a greater quantity of alkali than common kelp—A recapitulation of all theſe experiments would be inconſiſtent with the intended brevity of this publication. I ſhall, therefore, only mention what he conceived to be the beſt form of a furnace.

It conſiſts of one fire-place, covered with an arch, which communicates with four reverberating cavities, into which the ware is to be thrown. This fire-place, with a ſmall quantity of fuel, produced a kelp of greater ſtrength than any he had examined during his long practice; and, upon calculation, it was found that the expence of furnaces and fuel, was greatly more than repaid by the increaſed value of the kelp.

I find, that a ſpecial committee of the Highland Society, aſſiſted by the late celebrated Dr. Black, had examined theſe furnaces, and reported to the Society their approbation of them. They alſo mention ſeveral other particulars, which are of importance to be more generally known.

"Mr Jameſon further ſtated, that the expence of theſe kilns would be of moderate amount; that of the ſingle 7l. or 8l. and of the four united, (which is the one I have deſcribed), about

about 30l, with the addition of a ſmall ſum for a ſhade or cover, to protect the article when made, from the weather; but that ſuch an expence would be repaid by the additional quantity of good kelp, produced from the ſea weed, burnt into 10 tons; which the kilns would produce in a very ſhort time, the ſingle one burning one ton, and the quadruple four tons a day †."

Merchants, in their examination of kelps, are poſſeſſed of a few rules, which they generally follow, in determining their relative value; theſe are, taſte, ſmell, colour, and compactneſs. Theſe will give us a very vague idea of their value; and it requires no foreſight to perceive, that truſting to external characters, in ſo heterogeneous a maſs as kelp, muſt often lead the unwary buyer into a diſagreeable predicament, in purchaſing as good, what upon actual trial he finds of comparatively little value. Theſe remarks are not idle conjectures; for I have often ſeen them verified, to the no ſmall detriment of the manufacturer, and have as often regretted that ſo little attention ſhould be paid to the aſcertaining the proportion of alkali, &c.

Mr Kirwan of Dublin, whoſe active induſtry is now well known to all Europe, is the firſt who has engaged ſeriouſly in this

† Tranſactions of the Highland Society, Vol. I. p. xxiv, xxv.

this inveſtigation; and the reſults of his labours are detailed in the 3d vol. of the Tranſactions of the Royal Iriſh Academy.

Having favourable opportunities, through the good ſervices of ſome of my friends, of procuring kelps and barillas, I aſcertained the proportion of pure alkali in each of them: in ſome by the teſt of ſulphat of argill, which is employed by Mr Kirwan; in others, by uſing an acid of known ſtrength, the method recommended by Dr. Black.

Table of the Proportion of ALKALI *contained in different kinds of* BARILLA *and* KELP.

		In the 100lb.
Barilla and	Alicant—good	$23\frac{1}{2}$.
	Teneriff—bad -	8 lb. 7 oz. 120 gr.
Kelp from	Norway indifferent	2 lb. 11 oz.
	Shetland—indifferent	2 lb. 6 oz.
	Lewis—indifferent	2 lb. 11 oz.
	Ibid—indifferent	2 lb. 6 oz.
	Weſt Highlands—much damaged - -	1-3d of lb.

Arran

Arran - - -	$3\frac{1}{2}$ lb.
Ifla—good - -	4 lb.
Mull—good - -	$4\frac{1}{2}$ lb.
Morven—good -	$4\frac{1}{2}$ lb.
Ifland Skye—good -	5 lb.
Leith fhores - -	4 lb.

In judging of the value of kelp, it is not fufficient that we have afcertained the proportion of foda ; feveral other circumftances muft be attended to. In the firft place, in judging of the value of a cargo, we muft carefully examine its general appearance, which comprehends the fize of the maffes, the greater or lefs quantity of mixed ftony matter, the degree of compactnefs, the proportion of diffufed charcoal, the cafticity, its wetnefs or drynefs, &c. We then take pieces as different as poffible from each other, and as expreffive of the character of the whole as we can, pound them, and take any intermediate quantity, as an ounce, and afcertain the proportion of foda, which being done, will afford us as juft an idea of its value, as from the nature of circumftances we can obtain.

Chemical Analysis of Fuci.

Our knowledge of the saline and earthy matters contained in fuci, is as yet very limited, which is to be regretted, when we consider the utility and importance of such an investigation. Bouvier, in the Annales des Chymie for 1791, has given us an analysis of what he names Fucus Helmenthorcoton. From his experiments, it appears, that no uncombined alkali is present, and that the principal saline compound is muriat of soda, (common salt.)

Vauquelin has found soda ready formed in some maritime plants. The plants which give most alkali by combustion, are not those that grow under the sea-water, as fuci, but those that grow upon the land near to the shore, as salsola kali, soda, sativa. The salsola sativa is the species which is cultivated in Spain for the making of barilla, and the exportation of the seeds is punished by death.

Cultivation of Fuci.

The cultivation of fuci upon shores, is now become an object of some consequence, not only from their value, as affording kelp, but also on account of their successful use as a ma-

nure.

nure. It has, therefore, been recommended to place ſtones upon the ſhores, which, in many places can be done at ſmall expence; and theſe in two years, become covered with fuci, in ſuch a ſtate, as to admit of cutting. Various kinds of ſtones have been tried, as baſalt, ſandſtone, and limeſtone ; this laſt is by many reckoned the beſt, and, next to it, baſalt.

FROM HUNA TO THE FRITH OF FORTH.

CHAP. XXX.

Journey from HUNA, *upon the ſhore of the Pentland Frith, by Wick, Berrydale, Dornoch, Tain, Cromarty, Fort-George, Nairn, Forres, Elgin, Loſſiemouth, Cullen, Portſoy, Banff, Aberdeen, Stonehaven, Dundee, to the Frith of* FORTH.

ALTHO' it required nearly ſix weeks to traverſe the Orkney Iſlands, and that journey proved the moſt unintereſting I had ever made; yet I had the pleaſing reflection of having examined a country, the mineralogy of which was before unknown, and of having now finiſhed my journey thro' the greater part of the Scottiſh Iſles. But I cannot leave them, without acknowledging, in the warmeſt manner, my ſenſe of the

the hoſpitality of the inhabitants : a kindneſs the more agreeable, that it ſeemed, on their part, to look for no return, and to proceed from feelings ſo conſonant and natural, that they had forgot that it was unuſual, and confined to thoſe remote highlands, where the better feelings of the heart more freely expand themſelves.

The weather being favourable, Mr Watſon accompanied us to the ferry, which is at a place called Burwick, ſituated upon the ſouth-weſt end of the iſland of South Ronaldſha. We bade him adieu, and left with regret a friend to whoſe kind attentions we had been ſo much indebted. Altho' the boat was excellent, we did not embark without ſome dread, from the recollection of the many terrible accidents which have happened in croſſing the frith. Luckily the weather proved fine; ſo that we landed at Huna, upon the coaſt of Caithneſs, after a paſſage of about two hours and a half. In croſſing, we came cloſe to the ſmall, low iſland of Stroma, which appears to be compoſed of ſandſtone and ſandſtone flag: indeed we were informed that a great number of flags are annually quarried in this iſland, and carried to the coaſt of Caithneſs. At Huna, the ſhore is low, and is compoſed of coarſe argillaceous ſandſtone; and the coaſt and country, from Duncanſbay Head to Dunnet Head, are evidently formed of ſimilar rocks. As the poſtman was juſt ſetting out for Wick, which is the firſt town we meet with

in

in going fouthward, we embraced the opportunity of having him as a guide. The country continues low and flat, only in a few places varied by confiderable hills; and cultivation feems very fparing. Near to Kies Caftle we encountered a tedious fandy beach, over which we walked; and in feveral places we obferved that the peat had been dug from under the fand. At the extremity of this beach, we paffed a formal tower, a feat of Sir Benjamin Dunbar; and further on, towards the Nofs Head, the caftles of Guernigo and Sinclair were feen perched upon lofty fea-cliffs; and foon afterwards we came to the fmall borough town of Wick. The country, thro' which we had paffed, is compofed of fandftone and fandftone flag; but, in many places, I obferved maffes of breccia, compofed of fragments of red granite, micaceous fhiftus, and quartz, cemented by an arenaceous bafis: but I could not difcover how it is connected with the other ftrata of the county.

Wick is the chief county town in Caithnefs; is of little extent; and lies upon the north-eaft fide of what is called Wick river. The ftrata, upon both fides of the river, and in the neighbourhood of the town, are compofed of fandftone flag, which is difpofed in ftrata nearly horizontal; and, in the bed of the river, I alfo obferved great maffes of the breccia juft mentioned.

We

We left Wick in the morning for the houfe of Berridale. We continued our journey for feveral miles thro' a heath-covered country, pretty level, but brown and bleak, with little cultivation, and no variety of ftrata; fandftone and fandftone flag being the only rocks. At Poakmaft the country is more hilly; and now and then the great mountains, the Paps of Caithnefs, and the lofty Morven, appeared at a confiderable diftance, forming a ftriking contraft with the low, mean-looking country thro' which we were paffing. From Poakmaft to Dunbeath we had ftill the fame bleak fcene; and this tedious uniformity was only varied by the appearance of old, ruinous caftles, perched upon the rocky cliffs on the fea-fhore, or reclufe gentlemen's feats fituated amid brown defert heaths.

After paffing Dunbeath, we continued walking for about four miles, along the fea-fhore, thro' a heath-covered country, when we came upon the fide of a valley beautifully covered with natural wood; and we obferved, fituated in its bottom, the neat inn of Berridale, for which travellers have to thank the generofity of Sir John Sinclair. As we defcended, by a winding road, to the houfe, the valley became more reclufe: the diftant mountains being hid by the fides of the valley, and a bridge thrown acrofs a water which runs over a broken channel overhung with natural wood, added much to its beauty.

This

This is indeed a fcene that might be admired under a milder climate. The ftrata, from Dunbeath to this valley, are formed of fandftone, fandftone flag, and a blue fpecies of fecondary ardefia: the higher grounds appear to be entirely of primitive rocks.

As the weather was delightful, we did not proceed on our journey homewards, but next morning we agreed to afcend the mountains in the neighbourhood, fo that we might obtain fome information as to the ftructure and compofition of the high parts of the country. After breakfaft, we took a winding and pretty fteep road upon the fouth fide of the valley, which led thro' the natural wood, and foon reached the fummit of the valley. From this, we had a fine view of Morven, Scuraben, and the neighbouring mountains; yet we were feparated from them by a long, dreary peat muir. Having croffed the muir, which was very fatiguing, (owing to its broken furface,) we at length reached the bottom of Scuraben. We here found a tolerable tract, which led us a confiderable way up the mountain. At the termination of this tract, we turned weftward, and walked over a wildernefs of ftones, and thro' a thick fog, to the fummit of the mountain of Scuraben. The thick mift entirely prevented us from feeing the neighbouring country; and we were forced to defcend into a hollow

upon

upon the lea ſide of the mountain, to ſhelter ourſelves from the piercing cold and drizzling rain. We laid ourſelves down behind a great maſs of rock, anxiouſly waiting for the diſperſion of the fog ; and, being much fatigued, fell aſleep, but awaked ſoon afterwards, cold and wet, and ſtill involved in a thick miſt. As our ſituation was now by no means agreeable, we quitted the hollow in which we had taken ſhelter, and deſcended by the north-weſt ſide of the mountain, and, after a long walk, we were happy again to reach the ſweet retreat of Berridale.

From the obſervations which I made upon the ſummit of the hill, and in the aſcent, the following appears to be the nature of the ſtrata. The lower part of the country is common argillaceous ſandſtone, and ſand ſandſtone flag ; but, as we aſcend, the next rock is an arenaceous breccia, which has, immerſed in it, fragments, of various ſizes and ſhapes, of red granite, micaceous ſhiſtus, and quartz ; and to this ſucceeds a rock of quartz, which reaches to the ſummit of the mountain. This quartz is ſometimes ſo intermixed with the mica, as to form micaceous ſhiſtus ; and very often it has a brecciated appearance. Morven, with the other neighbouring mountains, from their white colour, appear to be compoſed of a ſimilar quartzy rock. It would be an object well worthy the attention of the mineralo-

 giſt,

gift, to examine the junction of this quartzy rock with the ſandſtone ſtrata, and alſo to determine with accuracy the angle of elevation, &c. of theſe ſtrata.

Having reſted after the fatigues of our journey to Scuraben, we left Berridale early in the morning. The weather was charming; and the perfume of the wild flowers, which was diffuſed all around, rendered the beginning of our journey very agreeable. We aſcended firſt by a ſteep, winding road, which was covered with maſſes of ſandſtone breccia; and conſiderable blocks of granite and micaceous ſhiſtus lay ſcattered upon the road. From this, to the valley which is formed upon one ſide of the Ord of Caithneſs, the ſame ſtrata continues: that is, upon the ſea-ſhore, red argillaceous ſandſtone; and, farther up, ſandſtone breccia, which contains fragments of granite, micaceous ſhiſtus, and quartz, immerſed in an arenaceous baſis; and to this ſucceed the primitive ſtrata. As we deſcended into this valley, we obſerved the road covered with great maſſes of granite; and the hills above (which are heath-covered) appeared alſo to be formed of granite.

We now aſcended from this valley by the ſteep mountain called the Ord of Caithneſs, and, after a fatiguing walk, we reached the narrow paſs which forms the entrance into Sutherlandſhire

landſhire from the north. Before, were the diſtant mountains of Roſs and Inverneſs ſhires; but, below, was the ſea-coaſt of Sutherland, which had a ſingular appearance: the cultivated ground forming a low and nearly level bank, which is ſkirted by dark mountains of a conſiderable height. The paſs itſelf was bounded upon one ſide by a ſteep mountain of granite †; on the other, was a frightful precipice hanging into the ſea, and compoſed of a ſpecies of breccia, which, as far as my ſhort time would allow me to determine, ſeems to lie upon the granite. We now deſcended, by a winding road, to the bank we have juſt mentioned, and walked along it to a village called Helmſdale, where unluckily we could get little to ſatisfy our craving hunger. This village, or kraal, is ſituated in a valley of conſiderable magnitude, and is bounded on both ſides by mountains of granite. We now croſſed the water of Helmſdale, and walked along the ſhore, by the ſide of the bank which is continued from Helmſdale, to a dirty hut, which paſſes for an inn, and is called Wilk Houſe. This bank is compoſed of ſtrata of red and white-coloured ſandſtone; but upon the ſhore, at a little diſtance from this ſandſtone, there are low, ſhelving rocks, of an argillaceous breccia, which is compoſed of fragments of ſandſtone and quartz immerſed in an argillaceous breccia. Theſe ſecondary ſtrata are bounded by higher mountains, which are primitive, and probably of granite.

† This granite is compact, and compoſed of felſpar and quartz.

After leaving Wilk houfe, the bank, which had accompanied us from the Ord of Caithnefs, was now fucceeded by flat ground; but our general courfe was thro' fandy beaches: and this, with the great heat of the day, rendered our journey very fatiguing. As we approached near to Dunrobin Caftle, the fine feat of the Countefs of Sutherland, the country becomes wooded; and at length we obferved the caftle rifing with much dignity among the fine wood with which it is fo richly ornamented. Soon afterwards, we reached the kirk of Golfpie. Having refted a little, we continued our journey over a flat fandy tract of country, which is bounded by high primitive mountains. About three miles from Golfpie, we came to a river, and were here detained for nearly an hour until the obftinate boatmen would ferry us acrofs; and then walked among fand banks, and over heath muirs, to Dornoch, where we arrived in the evening, completely fatigued, after a walk of nearly 20 hours. I was a good deal furprifed to meet with many pieces of pumice ftone among the fand banks between Golfpie and Dornoch: thefe have affuredly been driven on fhore from the fea, as I have already mentioned to be the cafe with regard to the pumice found upon the fhores of the Shetland Iflands.

Dornoch is an old, defolate-looking town, only remarkable for the ruins of its cathedral.

We

We left Dornoch in the morning, for the village of Tain. The road to the ferry, which is upon the north fide of the frith of Dornoch, is thro' a low, level, and pleafant country. It is in many places well cultivated, and ornamented with wood, that extends to a confiderable height upon fome of the hills bounding the low country. The ftrata of the lower parts are of red fandftone; and I obferved many fragments of micaceous fhiftus, and granite, which have been wafhed from the neighbouring mountains. We now croffed the ferry, which is about three quarters of a mile broad. In our paffage, looking downwards, we had a pretty extenfive view of the low fandy country on both fides of the frith; a profpect not unlike the views we have on many of the low fhores on the Englifh coaft. The view upwards was of a very different kind: it was the wild and rugged mountains of Rofs-fhire, which in fome places appeared white with fnow, in others richly covered with wood. The road from this to Tain led firft thro' a fweet flat adorned with broom; then along a road bounded by trees; and the fcene was again varied, before we reached the town, by a difagreeable tract of heathy and fandy ground. The ftrata, in this tract, appeared to be principally red-coloured argillaceous fandftone: but, as we approached the town of Tain, I obferved confiderable maffes of granitic porphyry, gneifs, micaceous fhiftus, and hornblende fhiftus. Whether all thefe

rocks

rocks form ſtrata in the neighbouring hills, or are only maſſes derived from a breccia which I obſerved lying upon different parts of the road, I had not an opportunity of determining.

After dinner, we walked to the ferry of Cromarty. The road led thro' a pretty flat country, and the ſtrata ſeemed to be entirely of red-coloured argillaceous ſandſtone; and, in ſeveral places, I obſerved great maſſes of breccia, which is formed of fragments of granite, gneiſs, micaceous ſhiſtus, hornblende rock, and quartz. We now croſſed a ferry, of about one mile and a half broad, to the town of Cromarty. This is a neat highland town, and is much beautified by the fine grounds and handſome ſeat of the Earls of Cromarty. The prevailing ſtrata in the neighbourhood of this town, and what forms both ſides of the entrance of the Cromarty frith, is a red-coloured argillaceous ſandſtone.

We left Cromarty early in the morning, for Fort-George. The country is, all the way, pretty flat. We could not obſerve the ſtrata, owing to the covering of heath, until we came near to Fortroſe; but in ſeveral places I obſerved maſſes of granite, gneiſs, micaceous ſhiſtus, hornblende rock, and alſo maſſes of arenaceous breccia. As we deſcended to Fortroſe, ſtrata of arenaceous breccia made its appearance; and the coaſt of

of the Murray frith, from Fortrofe to the entrance of the Cromarty frith, feemed to be compofed of red-coloured argillaceous fandftone, with ftrata of arenaceous breccia. We now walked down to the ferry-place, and croffed the frith, which is about two miles broad, to Fort-George. This fort, the moft complete piece of fortification in Great Britain, is fituated upon a low point of land which juts acrofs the Murray frith, and is built of red and white-coloured argillaceous fandftone. From it, we have a fine view of the frith, which expands beyond the fort, and is bounded by lofty hills; and this profpect is terminated by the capital of the highlands, the picturefque town of Invernefs, with great mountains rifing on both fides of it.

If we look at the map, we fhall obferve that Scotland is deeply indented both on its eaft and weft fide. In the eaft, the fpacious Murray frith interfects the country as far up as Invernefs; while, upon the weft fide, Linnhe Loch reaches to Fort-William. A great valley, about 60 miles long, extends between thefe arms of the fea: it is bounded by lofty mountains; and its bottom is covered, excepting for about 17 miles, with deep lakes. The land between the lakes is level, and compofed entirely of alluvial ftrata, excepting fome rocks to the fouth-weft of Fort-Auguftus †. It has been propofed to connect the lakes by a canal,

† Tranfactions of the Highland Society, vol. i.

a canal, and thus to ſave the tedious and dangerous paſſage by the Pentland frith; and, as the ground is level and ſoft, the expence would not be very great. This plan has much plauſibility; yet it would be more likely to meet with attention, if the mineralogy of the great glen was carefully examined. It is not improbable that promiſing appearances of ore may be diſcovered; and theſe, if worked with ſpirit, would employ many hands, and render a canal of vaſtly more importance. The few ſatisfactory mineralogical obſervations which have been made on this glen, have not been made with a view of diſcovering veins or beds of ore; ſo that we are, as yet, entirely ignorant of the mineral treaſures which it may contain.

We left Fort-George. The road led thro' a low, heathy country. On one hand was a ſandy flat, partly overgrown with heath, which ſeemed to have been formely covered by the ſea: on the other was a heathy country, and at a diſtance hills. I obſerved, upon the road, maſſes of granite, micaceous ſhiſtus, quartz, and ſandſtone. The ſandſtone ſtrata, which I obſerved cropping near to Nairn, ſeem to form the level part of the country; but the hilly part, from its general appearance, and the maſſes of micaceous ſhiſtus which are ſcattered about, ſeem to be of primitive rock.

We

We dined at Nairn, and ſet out for Forres. At a little diſtance from the town, we obſerved great ſand hills, and a terrible ſandy coaſt ſtretching towards the ocean. This ſcene was very ſtriking: the whole ſky was covered with dark clouds; yet the whiteneſs of the ſand cauſed the light to be ſo ſtrongly reflected, particularly from the hills, that they appeared as if the ſun was ſhining upon them. We ſtopt to examine them, and found that they were compoſed of fine white ſand, which does not lie in beds, but is irregularly heaped: a circumſtance ſufficiently concluſive that theſe accumulations have been produced by the blowing of the ſand. The whole of the neighbouring country is much covered with ſand, and ſome great eſtates have been almoſt deſtroyed by this ſand flood. We now continued our journey; and as we retired from the ſand hills, their appearance became the more ſtriking, as every object was clothed in a ſable hue, while their bright ſurfaces at length ſhone like luminous points upon the horizon. The road continues for a conſiderable way through a bleak country, but as we approach to the pleaſant town of Forres it aſſumes a rich and lovely aſpect. The ſtrata, all the way, are decidedly ſecondary, being of ſandſtone and baſalt; but the rocks in the higher parts of the country are probably of primitive rock, as is intimated by the fragments of granite and micaceous ſhiſtus which lie ſcattered about.

Forres is a neat, well-built town, pleafantly fituated between two little hills; but we could not enjoy the pleafure of examining it more at leifure, as the evening was at a clofe: and we were forced to proceed to Elgin, a diftance of 12 miles. At a little diftance from Forres, we examined, in the twilight, the famous pillar mentioned by Mr Pennant; and then continued our journey to Elgin in the dark. In the middle of the night, we croffed the blafted heath on which the weird fifters met Macbeth in the day of his fuccefs, and ftopt him with their prophetic greeting. The folitary hour of the night, the melancholy noife of the wind rufhing acrofs the heath, the glimmering of the Will-o'-the-wifp, excited in us that ftrange feeling of fuperftitious alarm of which every man muft at fome time or other have been confcious.

Although much fatigued with our long journey from Cromarty to Elgin, we rofe up early in the morning, and examined the magnificent ruins of Elgin cathedral.

We now continued our journey from Elgin towards Loffiemouth, which is fituated upon the fea-coaft. The country, for a fhort way, was very pleafing; but having reached an eminence above the town, we defcended into a flat, indifferently-cultivated country. As we approached Loffiemouth, the

the whole of the country appeared to be formed of bowlder ftones; and, near to the town, great banks, evidently left by the retiring of the fea, make their appearance. Thefe bowlder ftones are of granite, granitic porphyry, micaceous fhiftus, quartz, limeftone, and arenaceous breccia. At Loffiemouth, which is a trifling village, I obferved ftrata of red-coloured argillaceous fandftone; but no other rock was to be obferved in the neighbourhood. We now walked along the fhore for a confiderable way, ftill over bowlder ftones; we then changed our courfe, and continued walking for feveral miles upon the road to Fochabers, when we found the country to improve very much in beauty. As this route did not feem very interefting, we again traverfed the country until we came nearly to the mouth of the river Spey, which we croffed in a fmall boat. Here we walked along a beach of bowlder ftones, which was without any covering of heath, and was extremely fatiguing. Having reached its farther extremity, we walked, by a better road, to the fifhing town of Buckie. Upon feveral parts of the fhore, I obferved the red-coloured argillaceous fandftone; and at Buckie the ftrata became nearly vertical. At this place, as far as I had leifure to determine, the fecondary fandftone, which we had traced along the fhore all the way from the Pentland frith, difappeared, the fea-coaft being formed of primary ftrata. We now left the coaft, and afcended for a lit-

tle, when we came upon a level, which continues for a confiderable way either bare or heath-covered, and at a little diftance is bounded by mountains of confiderable height. As we approach to Cullen, the country becomes well cultivated ; and we pafs, to this fweet village, thro' very fine and rich plantations. It was almoft dark before we reached Cullen, fo that we probably paffed richly-wooded fcenes. The ftrata, all the way from Buckie, are entirely primitive, and are principally micaceous fhiftus, traverfed by quartz veins. In fome places I obferved maffes of granite: but I had not time to determine its pofition with regard to the other rocks.

In the morning, we left with regret the delightfully-fituated village of Cullen, and took the road which leads to Portfoy. A little way from the town, the country lofes much of its beauty, and the wood gradually difappears. About two miles from Cullen, we forfook the road, and walked towards the fhore, to view the old caftle, once the feat of Lord Oliphant. The caftle is built upon the fummit of a cliff about 80 feet high, which projects into the fea; and its ruins fhew that formerly it muft have been a place of confiderable ftrength. The times are now happily changed. In place of the fortrefs perched upon the almoft inacceffible fea-cliff, the feats of our chieftains are now placed in the moft enchanting fituations, and adorned with all the

the richnefs and luxurious variety of nature and art combined. It is a character which ftrongly marks the barbarifm of former times, and the prefent happy change of manners and government. The rock, upon which this caftle is fituated, is compofed of talcaceous fhiftus, which is difpofed in ftrata that are nearly vertical, and is more or lefs intermixed with quartz. I alfo obferved a great ftratum of compact quartz, which is in fome places between 16 and 17 feet wide. What is curious, this ftratum has, in fome places, the character of granular quartz; and it is often fo intermixed with talc, as to form a fpecies of talcaceous fhiftus. The ftrata of talcaceous fhiftus, upon one fide of the ftratum of quartz, are much twifted, while on the other they are perfectly regular.

We now continued journeying along by the fea-fhore, that we might have a better opportunity of difcovering any interefting appearances which were to be obferved. The cliffs continue to Sandfide to be compofed of nearly vertical ftrata of talcaceous and micaceous fhiftus; but, upon the fouth fide of Sandfide, I obferved a confiderable ftratum of fteel-grey, foliated limeftone, which lies upon an ardefia, or primitive argillaceous fhiftus, and this ardefia appears to be covered by a breccia. As the fea covered the greater part of this rock of breccia, I could not determine with certainty its pofition with regard to

the

the limeſtone. After paſſing this ſtratum of limeſtone, which, we were informed, runs a conſiderable way into the country, we came to an immenſe maſs of breccia, which ſeemed to be quite inſulated: it is not improbable, however, that, before the ſea had waſhed away the talcaceous ſhiſtus, the breccia would have been obſerved covering it. We ſtill continued our journey along the ſhore, until we came within a quarter of a mile of Portſoy; and, in that extent, I obſerved ſtrata of talcaceous, micaceous and hornblende ſhiſtus alternating with each other. We now walked to the town, which we found to be irregular and dirty.

As the rocks upon the ſea-ſhore, near to this town, are very intereſting, we agreed to ſtay a day or two, and examine them particularly. I was the more anxious to do this, as they have long attracted the attention of mineralogiſts; but their particular geognoſtic characters have never been detailed in any publication. After having examined theſe rocks, the following is the reſult of the obſervations which I made.

About a quarter of a mile from Portſoy, at the place to which I had traced the ſtrata in coming into the town, the talcaceous ſhiſtus appeared, in vertical ſtrata; and, nearly at the ſame place, I obſerved a ſtratum of white marble, which is marked

marked E, in the plan at the end of this volume. It is about 12 feet wide, and runs S. W. and N. E. which is in the ſame direction with the bounding ſtrata *. It appears to have been worked for ornamental purpoſes, as I obſerved ſeveral blocks upon the beach which ſeem to have been ſawed. To this ſtratum ſucceeds a vertical ſtratum of micaceous ſhiſtus †, marked F, which is compact, and of a blackiſh colour where in contact with the marble, but of a green colour where it is in contact with the next ſtratum, which is ſerpentine ‡. The ſtratum of ſerpentine, marked G, which ſucceeds to the talcaceous ſhiſtus, is of great width, and, like the other ſtrata,

* This marble is white, or clouded with ſteel-gray, but it is much mixed with ſcales of talc.

† The talcaceous ſhiſtus, which alternates with theſe ſtrata, has ſometimes ſo much the appearance of compact micaceous ſhiſtus, that it cannot be diſtinguiſhed from it; and as it approaches the marble, it is to be obſerved mixed with it, and paſſing into it.

‡ This ſerpentine is of various ſhades of olive and blackiſh green. Its fracture, which is either uneven, coarſe ſplintery, or even fine ſplintery, preſents canary-green ſcales. It is intermixed with various foſſils, as aſbeſtus, indurated ſteatites, talcite of Wallerius, calcaceous ſpar, and iron pyrites.

ſtrata, is nearly vertical, and runs in a ſimilar direction. It runs out into the ſea like a great wall; and this, with its green colour, gives it a ſingular aſpect. This ſtratum is bounded by a ſtratum of talcaceous ſhiſtus, H, which is almoſt entirely compoſed of quartz, where it is in contact with the ſerpentine; but as it approaches the next ſtratum which is marble, it has more of the talcaceous character, and is alſo traverſed by veins of quartz. The ſtratum of marble, I, is from 15 to 20 feet wide; is alſo vertical; but is of a bad quality, and will not ſerve for any ornamental purpoſe. It has, immerſed in it, pieces of quartz and talcaceous ſhiſtus. To this ſtratum ſucceeds a thin ſtratum of quartz; and this again is bounded by a thin ſtratum of talcaceous ſhiſtus, K. Both theſe ſtrata are only a few feet wide; and are ſucceeded by a ſtratum of marble, L, nearly of the ſame width with the former ſtratum, I. To this marble ſucceeds a great ſtratum of ſerpentine, M, which is of the ſame nature with the ſtratum we have before deſcribed. This ſtratum is bounded by hornblende rock *, N, which forms the rocks that ſurround the harbour of Portſoy, and continues beyond it towards a bay, the name of which I do not recollect.

* The hornblende rock is generally ſhiſtoſe, and has ſometimes ſcales of brown mica intermixed with it.

collect *. It is traverfed in feveral places by veins of granite, which run in different directions, and vary in breadth from one to eight or nine feet. At a little diftance from the fide of the bay I have juft mentioned, another ftratum of ferpentine, marked O, makes its appearance; and to it again fucceeds the hornblende rock, P, which is traverfed by veins of granite †.

We now walked along the fhore by the bottom of this bay; and, upon its oppofite fide, in place of the hornblende rock, there are rugged cliffs of micaceous fhiftus, which is in fome places alternated with quartz, and in others traverfed by confiderable granite veins. The micaceous fhiftus fometimes contains garnets; and the granite, which is great-grained, frequently contains cryftals of fhorl and mica, and fometimes it has the appearance that is called pierre graphique.

* The ferpentine, as it approaches the hornblende rock, becomes gradually intermixed with it, and at laft is not to be diftinguifhed from it.

† Betwixt Portfoy harbour and the bay, I obferved marble; but I could not determine how it lay with refpect to the other rocks; fo that I have not reprefented it in the plan.

Such appears to me the difpofition and nature of the ftrata upon the fhore at Portfoy *.

As the geognoftic characters of the ferpentine, at this place, are interefting, I fhall here mention, for the information of my readers, a few facts, which fhew that pretty nearly fimilar appearances have been obferved in other countries. Zobtenberg, in lower Silefia, confifts entirely of ferpentine, in which fome hornblende is found, and its ftrata are nearly vertical †. In the Miner's Kalendar for 1790, Kohler informs us, that ferpentine and primitive limeftone (marble) are nearly allied in their geognoftic characters, and that fometimes they are difpofed in ftrata which alternate. We are alfo informed that ferpentine refts upon gneifs, and even alternates with it ‡, and alfo with quartzy talcaceous fhiftus ||.

The

* Some travellers are of opinion that the ferpentine and marble form great veins, rather than vertical ftrata.

† 4 Berl. Beobacht. 353.

‡ Charpentier Mineralogifche Geographie von Churfachsichen Lande.

|| N. Nord. Beytrage. 149.

The appearance of the veins of granite traverſing hornblende rock and micaceous ſhiſtus, is by no means uncommon in Scotland; and in other countries ſimilar appearances have been very often obſerved. The pierre graphique has been obſerved, in Siberia, to form the ſides of veins where the topaz is found *; but at Sebnitz it is diſpoſed in beds with the common granite †; and, in the Uralian mountains, Herman obſerved it mixed with the common granite ‡. Patrin, who found it in Siberia with the topaz, conjectures that it may generally be conſidered as indicative of the preſence of theſe gems.

Having thus examined the ſtrata upon the ſhore, I walked into the country for about two miles; but could obſerve no trace of the ſerpentine, or marble, or talcaceous ſhiſtus, but in ſeveral places I obſerved the hornblende rock. I aſcended a hill a few hundred feet high; upon the ſide of it were maſſes of hornblende rock and gneiſs ſcattered about, but towards the ſummit it was entirely compoſed of ſhiſtoſe quartz. This

* J. de Phyſique. Ann. 1791.

† N. Bergmanniſhes Journal, B. 2. 443.

‡ Herman Mineralogiſche Beschreibung des Uralaiſchen Geburges. B. 1. ſ. 144.

is a rare rock in Scotland; nor has it been obferved but in a very few places upon the continent.

We now left Portfoy, and continued our journey by a good road which leads thro' the country towards the town of Banff. At the bridge of Boyne, I obferved a ftratum of foliated lime-ftone inclofed in the micaceous fhiftus, which is continued to this from Portfoy. We here obferved a beautiful wooded dell, with a fmall river running thro' it, extending below the bridge, and we were told that it continued to the fea-fhore. As it is in thefe places that good fections of the ftrata are often to be obferved, we forfook the high road, and walked thro' it. At a little diftance from the entrance, I again obferved the lime-ftone cropping thro' the ftrata of micaceous fhiftus; and, farther down, our attention was arrefted by the extenfive ruins of the caftle of Boyne, which is fituated upon one fide of the dell, and richly furrounded with wood. We continued our walk, and foon reached the opening of the dell, upon the fea-fhore, where we obferved confiderable quarries of the primitive lime-ftone. From this to Banff, we walked along the fea-fhore, which is low and rocky; and the ftrata, as far as I recollect, are principally compofed of micaceous fhiftus, which paffes, on one hand, to ardefia, and, on the other, to talcaceous fhiftus, and

and ſometimes it is to be obſerved alternating with hornblende rock ‡.

Banff is pleaſantly ſituated upon the ſide of a hill, which declines towards the ſea-ſhore. It has a harbour, which is protected by a good pier. The whole town has a neat appearance; and the buſtle of induſtry formed a ſtriking contraſt with the other towns we had paſſed thro'.

We intended to have continued our journey along the coaſt towards Peterhead; but, the weather being fine, we were deſirous to reach Aberdeen, ſo that I might examine the granite, and its connection with the other ſtrata. We therefore changed our route, and took the road to Turreff, which we reached befor the cloſe of the evening. The ſtrata are, all the way, of primary formation, and principally of micaceous ſhiſtus and ardeſia.

Having reſted all night at Turreff, we left it early in the morning; but unluckily a thick fog was ſpread all around, and

‡ I have to regret the loſs, both of the notes, and of the ſpecimens which illuſtrate this part of my journey; ſo that what I here write is from memory.

and ſoon the rain began to pour upon us, and continued without intermiſſion the whole day. We reached Aberdeen in the afternoon, drenched with rain, and much fatigued with our journey. The ſtrata are, all the way, of primary formation, and ſimilar to thoſe I obſerved between Banff and Turreff.

We remained here ſeveral days, expecting the weather to moderate, ſo that I might have an opportunity of examining the ſtructure and nature of the ſtrata for five or ſix miles around the city, and thus to acquire a knowledge of the poſition and different appearances of the granite. In the meantime, I examined the granite which is in the neighbourhood of the town, and obſerved, in the bed of the river Don, that it is covered by micaceous ſhiſtus, and that it ſeemed to be diſpoſed in great ſtrata, or beds. It has very often cryſtals of hornblende intermixed with the felſpar and quartz.

As the weather ſtill continued ſtormy, we were obliged to defer the examination of this country until another ſeaſon. Having taken leave of our friends, to whoſe kind attention we had been ſo much indebted during our ſtay at Aberdeen, we ſet out for the banks of the Forth.

The primary ſtrata of micaceous ſhiſtus continues for two

or

or three miles after leaving the town; when it is ſucceeded by red-coloured argillaceous ſandſtone, and ſandſtone breccia.

At Stonehaven, which is about 14 miles from Aberdeen, we obſerved the ruins of the caſtle of Dunotter, ſituated upon a rock of breccia.

From this, by Montroſe, Dundee, through a fine country called the Carſe of Gowrie, to Perth; and from that, by Cupar in Fife, to the banks of the Forth; the whole ſtrata are of ſecondary formation, and belong either to the tranſition or ſtratified rocks.

Plan of the Strata near Portsoy, Harbour.

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Marble

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